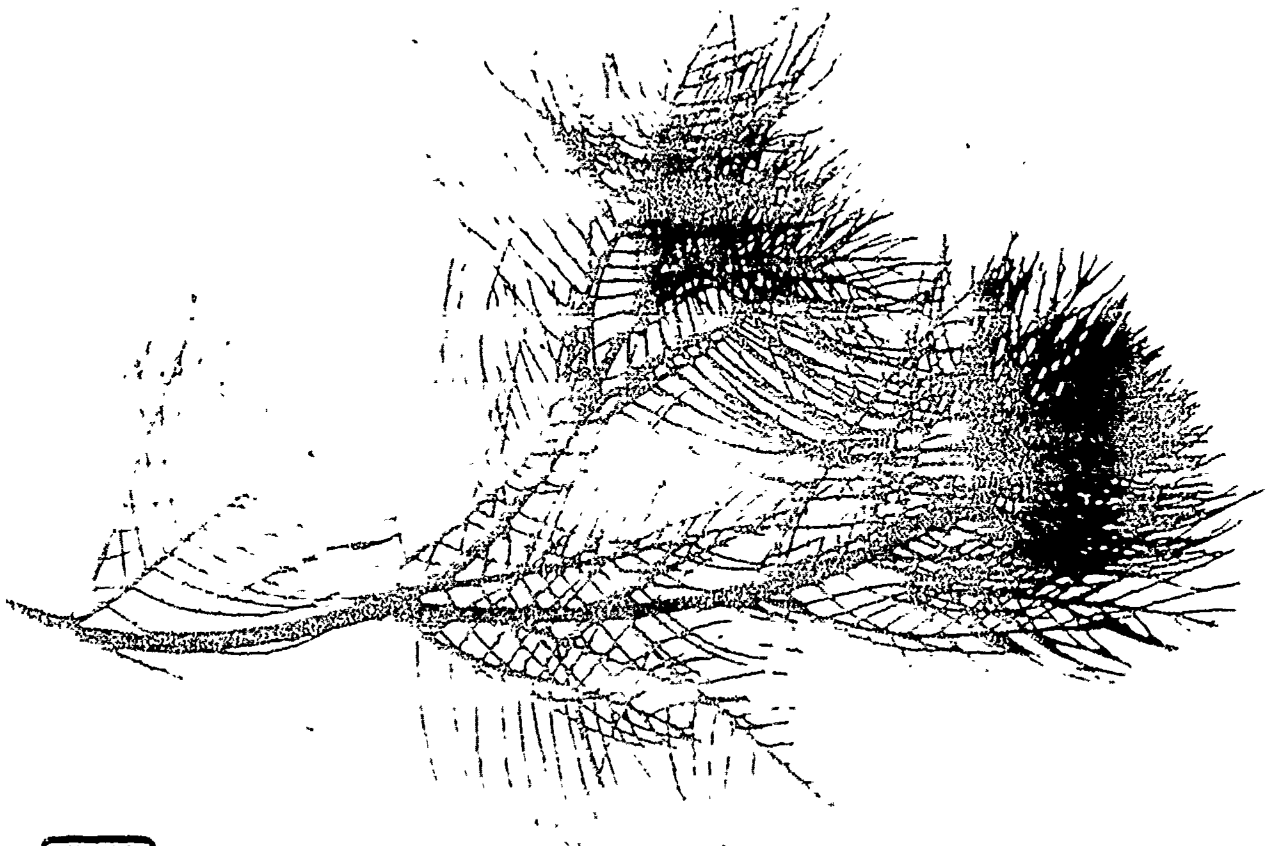
FINAL ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

STATE OF WASHINGTON AQUATIC PLANT MANAGEMENT PROGRAM



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The purpose of this supplement to the Environmental Impact statement (EIS, 1979) for the AquaticPlant Management Program (APMP) for the State of Washington is to review and update both geographic and treatment-related program elements in light of nearly 12 years of experience in the program of treating aquatic infestations of Eurasian Watermilfoil (Myriophyllum spicatum) and advancement of the state of the science of aquatic plant management. The base condition considered in this EISS is determined by conditions prevailing in APMP as described in the final EIS, plus modifications described in yearly Environmental Assessments on file at the Army Corps of Engineers, Seattle District.

The purpose of the APMP is to prevent the spread of watermilfoil and to alleviate negative consequences of thick growth of the plant, such as diminished accessibility and desirability of water bodies for public recreational use, increased public costs for cleaning accumulations of plant material at dams, obstruction of drainage, restriction of natural water flows, reduced navigability, and damages to fish and wildlife habitat.

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AQUATIC PLANT MANAGEMENT PROGRAM

FINAL ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT

Seattle District
March 1991

FINAL

ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

AQUATIC PLANT MANAGEMENT PROGRAM

STATE OF WASHINGTON

The responsible agency is the U.S. Army Corps of Engineers, Seattle District, Seattle, Washington. This final environmental impact statement supplement (EISS) to the final environmental impact statement (EIS) for the Aquatic Plant Management Program (APMP) for the State of Washington (October 1979), is dated March 1991.

FACT SHEET

Abstract: The purpose of this supplement to the Environmental Impact Statement (EIS, 1979) for the Aquatic Plant Management Program (APMP) for the State of Washington is to review and update both geographic and treatment-related program elements in light of nearly 12 years of experience in the program of treating aquatic infestations of Eurasian Watermilfoil (Myriophyllum spicatum) and advancement of the state of the science of aquatic plant management. The base condition considered in this EISS is determined by conditions prevailing in APMP as described in the Final EIS, plus modifications described in yearly Environmental Assessments on file at the Army Corps of Engineers, Seattle District.

The purpose of the APMP is to prevent the spread of watermilfoil and to alleviate negative consequences of thick growth of the plant, such as diminished accessibility and desirability of water bodies for public recreational use, increased public costs for cleaning accumulations of plant material at dams, obstruction of drainage, restriction of natural water flows, reduced navigability, and damages to fish and wildlife habitat.

Activities in the APMP are to control the growth of watermilfoil where it has negative effects on humans, fish, and wildlife; to prevent the spread of watermilfoil through chemical or mechanical methods; and to support research on biological controls and treatment methodologies for watermilfoil . The program has also included surveys of the geographic distribution of the plant in Washington waters and a public education program to reduce spread of the plant to uninfested State waters by recreationalists.

The purpose of this Final Environmental Impact Statement Supplement (EISS) is to tier, that is to update and summarize appropriate parts of the APMP EIS (1979) and subsequent annual programmatic Environmental Assessments which have concluded that impacts of changes introduced since inception of the APMP are not significantly different from those described in the EIS. Tiering allows Federal agencies to consolidate and review environmental analyses of programmatic changes and is described in 40 CFR 1502.20 and 1508.28 (Council on Environmental Quality's Guidelines for implementing the National Environmental Policy Act). The Corps determined that it was appropriate to review and update certain program elements for control of aquatic plants, and to summarize geographic changes in treatment areas and cumulative impacts. A description of significant changes and developments in the program (including new treatment areas and new information on various control methods in use or those being considered for future use) are presented in the EISS. Choice of an EISS format does not presuppose that changes in the program give rise to significant environmental impacts. The EISS determines a range of treatment options for watermilfoil in order to maintain a flexible program responsive to environmental laws and regulations and sponsors' needs.

Local sponsors select possible treatment sites from areas which contain watermilfoil . Ecology reviews proposals from the local sponsors and provides an annual work plan to the Corps for consideration for cost-sharing. The Corps determines whether the proposed work is within the scope of the authorized program and whether cost estimates are reasonable and appropriate. This EISS does not deal with economic feasibility of treatment methods but does provide recent cost information that may be considered by program

sponsors.Alternatives considered in this EISS are (a) continuation of treatment options described in the EIS (1979); (b) the preferred alternative, which involves reconsideration and update of treatment options described in 1979; and (c) discontinuation of the program, the no-action alternative. Both modes of treatment and geographic application are considered. The treatments considered are mechanical/physical control: mechanical harvesting, rotovation, suction dredge, bottom barriers, fragment barriers, and hand removal; chemical control: 2,4-D, endothall (dipotassium salt), dichlobenil, diquat, fluridone; biological control; and integrated control.

Changes in areas of treatment are determined by the State of Washington and the Corps after consideration of local needs, cost-sharing abilities, and associated environmental impacts. The geographic application area of the APMP within the State include the addition in 1982 of the Pend Oreille River between Box Canyon Dam and the Idaho border; Swofford Pond on the Cowlitz River, Lewis County, which was treated in a pilot program with fluridone (trade name Sonar) in 1988 and 1989; and the deletion of the Okanogan-Columbia Rivers near Malott, Washington, which were treated with 2,4-D from 1981 through 1983 to avert need spread into the mainstream Columbia River, but are no longer proposed for treatment in the program because the weed has now spread into the Columbia.

The tentatively selected program is continuation of the basic program with addition of the herbicide Sonar. The EISS concludes that impacts from the proposed activities (including ongoing activities) are fundamentally the same as those occurring under the program as conceived in 1979. Analysis indicates that certain chemical, physical and mechanical modes of treatment remain acceptable or exhibit a similar degree of acceptability in the State of Washington for the APMP cost-sharing program.

The general adverse environmental impacts of the program would not be significant. Impacts common to all methods include destruction of aquatic vegetation other than Eurasian watermilfoil , other vegetation has habitat value for freshwater invertebrates, vertebrates, fish and birds. These impacts would be minor due to the limited extent of treatments, which are generally in areas of upstream encroachment of Eurasian watermilfoil (prevention) or in high-use areas such as swimming beaches (control), and because treated areas usually exhibit low habitat value due to overgrowth of by watermilfoil. A potential impact from methods which kill but do not remove the weed from the water include depressed aquatic dissolved oxygen values; however, due to flowing or diluting conditions existing at such sites, dissolved oxygen is not anticipated to reach toxic levels. This has been confirmed by past monitoring.

Specific treatments would have minor adverse impacts. Minor, short-term increases in dissolved chemicals in the water column could occur from potentially sediment suspending techniques such as rotovating. The potential for rotovation to physically disturb submerged historic or prehistoric features is also considered on a site-specific basis; the EISS concludes that certain areas in the Pend Oreille River system have a potential for losses and these areas are not recommended for this treatment. Herbicides in water could have toxic effects on animals or humans. Risk analyses to ecological and human health are presented, and it is concluded that the selected herbicidal

formulations and techniques, when applied as suggested, would not provide significant risk for aquatic communities nor for human health; risk management elements are suggested to assure this conclusion. Data gaps in pertinent literature were identified and considered in formulating these conclusions.

The EISS recommends the action alternative to update the program to add the herbicide Sonar and maintain the availability of the other major treatments.

EXECUTIVE SUMMARY

1. Major Conclusions and Findings. The Aquatic Plant Management Program (APMP) addresses the need for management of the nonnative plant Eurasian watermilfoil, *Myriophyllum spicatum*, in the State of Washington. The APMP was authorized on 17 June 1980 through a directive by the Office of the Chief of Engineers in accordance with Public Law 89-298 and Section 302 of the Rivers and Harbors Act of 1965, and the design memorandum entitled "State of Washington Aquatic Plant Management Program," dated October 1979. The final environmental impact statement (EIS) for the APMP for the control of Eurasian watermilfoil in the State of Washington was dated October 1979 and filed on 9 May 1980. The purpose of this draft environmental impact statement supplement (EISS) is to update and summarize appropriate parts of the 1979 EIS and subsequent annual programmatic environmental assessments for use by the State of Washington Department of Ecology, the Municipality of Metropolitan Seattle (METRO), and sponsors seeking information on environmentally-compatible means of managing watermilfoil growth and spread.

The APMP EISS includes a review and update of certain program elements for control of aquatic plants, and a summary of geographic changes in treatment areas. The following programmatic changes have been made since the 1979 EIS and documented in yearly environmental summaries.

Geographic

- The Pend Oreille River between Box Canyon Dam and the Idaho border was added to the program in 1982. Also, the treatment areas have changed with time; treatment for 1989 includes approximately 100 acres of rotovation.

- Swofford Pond on the Cowlitz River, Lewis County, was treated with fluridone (trade name Sonar) as a pilot program in 1988 and 1989.

- The Okanogan-Columbia Rivers near Malott, Washington, were treated with 2,4-D from 1981-1983 but are no longer proposed for treatment in the program.

Methodologies

- Mechanical harvesting and handpulling remain approved methods for treatment. New approaches are discussed.

- Bottom tillage, or rotovation, is a previously approved method that has been demonstrated as a more effective method of treatment with fewer environmental disruptions and less damage to bottom-dwelling organisms than originally predicted.

- Bottom barriers are still proposed only in high use areas such as swimming beaches because of their great expense. Additional information on effects of bottom barriers on water quality and benthic invertebrates is included.

- Suction dredging (never yet used in the cost-share program) and fragment barriers (which have proven ineffective) remain the same as outlined in the EIS.

• 2,4-D is currently unavailable for aquatic treatment in our region (pending final re-registration action by EPA).

• Fluridone (trade name Sonar) is now included in the program.

• Endothall risks to human health and the aquatic environment have been updated and included in the EISS. An issue has arisen regarding risk to human health in the maximum exposure scenario for incidental water consumption that suggests that cautious application of endothall combined with risk management practices would be prudent.

• Diquat is not recommended for use in the program at this time.

• Dichlobenil is not encouraged for control treatment.

• Biological control methods (herbivorous fish and insects, pathogenic microorganisms, and competitive plants) show promise, and are in various stages of development. Grass carp are available for effective control of watermilfoil. It may be several years before biological agents, such as insects, have been thoroughly tested and approved for use.

o Integrated control methods (using two or more of the above methods) have shown some success in the program. In general, they have involved a mechanical method such as dredging along with a small-scale treatment (bottom barrier or herbicide). As biological techniques are shown to be available, they may be effectively combined as well.

Adverse Impacts and Known Data Gaps

• Short-term adverse environmental impacts caused by rotovation include increased turbidity, displacement of the benthic community, and re-introduction of nutrients or pollutants from sediments into the water column.

• Potential short-term impacts caused by chemical control include death or damage of nontarget species, decreased dissolved oxygen, release of nutrients into the water, and restriction of recreational activities.

• Long-term effects of rotovation involve removal of most aquatic plants from the treatment areas, although reestablishment of plant communities usually occurs within the next annual cycle. Long-term effects of chemical treatment include loss of habitat for fish and other aquatic organisms; furthermore, aquatic herbicides remain in the water and sediments for varying periods of time depending on the chemical used and on physical characteristics of the treated water body.

• Primary data gaps for chemical treatments include information on the significance of endothall as an irritant to juvenile fish, information on its chronic toxicity, and information on the persistence of the chemical when applied as a granular formulation.

2. Areas of Controversy and Unresolved Issues. This EISS provides

information on all available treatment options under the Aquatic Plant Management Program. The Corps has worked closely with resource agencies and the public to document impacts of mechanical, chemical, and biological control methods; however, the use of herbicides and biological pathogens, insects, and herbivorous fish may require case-specific considerations by cost-sharing applicants. These could (and often do) include seasonal conditions for application, monitoring, or restrictions by local entities of certain program alternatives. (For example, METRO has a policy discouraging use of herbicides in King County).

3. Relationship to Environmental Requirements. Compliance is summarized in table i-1. Compliance as used therein indicates the consistency of the program alternatives (treatment options recommended and geographic extent) with the laws, orders, plans or regulations. Compliance categories used in this evaluation were assigned based on the following definitions:

- Full compliance - all requirements have been met.

- Partial compliance - some requirements remain to be met, will be met by completion of the EISS, or will be met by acquisition of a permit (as stated).

- Not applicable (N/A) - the statute, executive order, or other policy is not applicable to the program.

The no-action plan is generally in compliance with all applicable requirements. The following table summarizes the status of the recommended program.

TABLE i-1

COMPLIANCE OF RECOMMENDED PROJECT WITH ENVIRONMENTAL REQUIREMENTS

FEDERAL STATUTES	COMPLIANCE
Clean Air Act, as amended, 42 USC 1857h-7 et seq.	Full
Clean Water Act, as amended (Federal Water Pollution Control Act), 33 USC 1251 et seq.	Full
Coastal Zone Management Act, as amended, 16 USC 1451 et seq.	Full
Endangered Species Act, as amended, 16 USC 1531 et seq.	Full
Estuary Protection Act 16 USC 1221 et seq.	Full
Federal Water Project Recreation Act, as amended, 16 USC 460-1 (12) et seq.	Full
Water Resources Act, 1976, Section 150	Full
Fish and Wildlife Coordination Act, as amended, USC 661 et seq.	Full
Land and Water Conservation Fund Act, as amended, 16 USC 4601-4601-11 et seq.	Full
Marine Protection, Research and Sanctuaries Act, 33 USC 1401 et seq.	N/A
National Environmental Policy Act, as amended, 42 USC 4321 et seq.	Partial
Rivers and Harbors Act, 33 USC 403 et seq., 33 USC 401	Full

TABLE i-1 (con.)

FEDERAL STATUTES	COMPLIANCE
Watershed Protection and Flood Prevention Act, 16 USC et seq.	N/A
National Historic Preservation Act, 16 USC 407a et seq.	Full
Wild and Scenic Rivers Act, as amended, 16 USC 1271 et seq.	N/A
Executive Orders, Memoranda:	
Flood Plain Management, 11988	Full
Protection of Wetlands, 11990	Full
Environmental Effects Abroad of Major Federal Actions, 12114	N/A
Executive Memorandum Analysis of Impacts on Prime and Unique Farmlands in EIS, CEQ Memorandum, 30 August 1976	N/A
STATE AND LOCAL POLICIES	COMPLIANCE
Washington State Constitution	
Article XV. Harbors and Tide Waters	Full
Article XVII. Tidelands	Full
Multiple Use Concept in Management and Administration of State Owned Lands (RCW 79.68.060)	Full
State Environmental Policy Act of 1971 (RCW 43.21)	Partial

TABLE i-1 (con.)

STATE STATUTES	COMPLIANCE
Water Resources Act of 1971 (RCW 90.54)	N/A
Shoreline Management Act of 1971 (RCW 90.58) and Grays Harbor County Shoreline Management Program	Full
Water Pollution Control Act (RCW 90.48)	Full
PERMITS REQUIRED:	
Shoreline Substantial Development Permit	Partial (For Some Treatments)
Shoreline Conditional Use Permit	No
Washington Department of Natural Resources Lease of Tidelands	N/A
Washington Departments of Wildlife and Fisheries Hydraulic Project Approval	Partial (For Some Treatments)
Washington Department of Ecology Water Quality Certification	Partial (For Some Treatments)
Washington Department of Wildlife	Partial (for Grass Carp)

ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

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SECTION 1. THE AQUATIC PLANT MANAGEMENT PROGRAM

1.01 Background. The Aquatic Plant Management Program (APMP) addresses the need for management of the nonnative aquatic plant Eurasian watermilfoil, *Myriophyllum spicatum*, in the State of Washington. This program is cost-shared between the State of Washington Department of Ecology (Ecology), which is the local sponsor representing county and city entities, and the Seattle District, U.S. Army Corps of Engineers (Corps). The Corps' authority for involvement is a directive by the office of the Chief of Engineers on 17 June 1980 in accordance with Public Law 89-298 and Section 302 of the Rivers and Harbors Act of 1965, and the design memorandum entitled "State of Washington Aquatic Plant Management Program" dated October 1979. The final Environmental Impact Statement (EIS) for the Aquatic Plant Management Program for the Control of Eurasian Watermilfoil in the State of Washington was dated October 1979 and filed on 9 May 1980.

Heavy infestations of Eurasian watermilfoil (watermilfoil) were first discovered in western Washington in the mid-1970's, and entered eastern Washington through the Okanogan River drainage in 1977. Infestations have since spread to additional lakes and from the Canadian border to the present downstream limit near The Dalles Dam. Starting in 1980, the APMP was implemented to control infestations of watermilfoil and to prevent its spread.

The purpose of the APMP is to prevent the spread of watermilfoil and to alleviate negative consequences of thick growth of the plant, such as diminished accessibility and desirability of water bodies for public recreational use, increased public costs for cleaning accumulations of plant material at dams, obstruction of drainage, restriction of natural water flows, reduced navigability, and damages to fish and wildlife habitat.

Activities in the APMP are to control the growth of watermilfoil where it has negative effects on humans, fish, and wildlife; to prevent the spread of watermilfoil through chemical or mechanical methods; and to support research on biological controls and treatment methodologies for watermilfoil. The program has also included surveys of the geographic distribution of the plant in Washington waters and a public education program to reduce spread of the plant to uninfested State waters by recreationalists.

1.02 Purpose and Need for Supplemental EIS (EISS) .

a. Purpose. The purpose of this final EISS is to tier, that is to update and summarize appropriate parts of the APMP EIS (1979) and subsequent annual programmatic Environmental Assessments which have concluded that impacts of changes introduced since inception of the APMP are not significantly different from those described in the EIS. Tiering allows Federal agencies to consolidate and review environmental analyses of programmatic changes and is described in 40 CFR 1502.20 and 1508.28 (Council on Environmental Quality's Guidelines for implementing the National Environmental Policy Act). The Corps determined that it was appropriate to review and update certain program elements for control of aquatic plants, and to summarize geographic changes in treatment areas and cumulative impacts. A

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Local sponsors select possible treatment sites from areas which contain watermilfoil. Ecology reviews proposals from the local sponsors and provides an annual work plan to the Corps for consideration for cost-sharing. The Corps determines whether the proposed work is within the scope of the authorized program and whether cost estimates are reasonable and appropriate. This EISS does not deal with economic feasibility of treatment methods but does provide recent cost information that may be considered by program sponsors.

b. <u>Program Changes</u>. The following programmatic changes have been made since the 1979 EIS.

(1) <u>New Areas for Treatment in Addition to Those Considered in the EIS</u>.

(a) The Pend Oreille River between Box Canyon Dam and the Idaho border was added to the program in 1982. Treatment for 1989 includes approximately 100 acres of rotovation.

(b) Swofford Pond on the Cowlitz River, Lewis County, was treated as a pilot study with fluridone (trade name Sonar) in 1988 and 1989. Information on monitoring of this treatment is discussed in this final EISS.

(c) The Okanogan-Columbia Rivers near Malott, Washington, were treated with 2,4-D from 1981-83, but are no longer proposed for treatment in the program. This is primarily because watermilfoil has spread past this area to the Columbia River.

(2) <u>Mechanical Treatment Methods</u>.

(a) Mechanical harvesting and handpulling remain approved methods for treatment. New approaches for these treatments are discussed in this EISS.

(b) Bottom tillage, or rotovation, was found to have limited acceptability for treatment in the EIS. Further evaluation of rotovation treatment in Canada and the U.S. indicates that it can be an effective method of treatment with fewer environmental disruptions and less damage to bottom-dwelling organisms than originally predicted. Physical damage to cultural resources in some areas is an additional consideration.

(c) Bottom barriers were included in the EIS and were proposed for employment only in high use areas such as swimming beaches because of their great expense. Recent testing has not provided new

information to alter this characterization, but has provided some understanding of the effects of bottom barriers on water quality and benthic invertebrates.

(d) Suction dredging, not used in the cost share program, and fragment barriers, which have proven ineffective, remain the same as outlined in the EIS.

(3) <u>Chemical Treatment Methods</u>.

( ) 2,4-D is currently unavailable for aquatic treatments in our region pending the Environmental Protection Agency (EPA) reconsideration of health information on this herbicide. Until a final decision is made on the herbicide's safety, it will not be included as an option for watermilfoil control.

(b) Fluridone (trade name Sonar, Dow/Elanco Products Company) has been included in the program. Fluridone is registered by EPA as an aquatic herbicide with low plant species-specificity, and is particularly suitable for slow-flowing waters which offer long chemical-plant contact times.

(c) Endothall risks to human health and aquatic environmental impacts have been updated relative to recent laboratory, field, and literature studies.

(d) Diquat is registered by EPA but is not approved by the State of Washington for aquatic use unless the applicant has total control over the proposed site. It is not recommended for use in the program at this time.

(e) Dichlobenil is not recommended for control treatment at this time. (This was also the conclusion of the 1979 EIS).

(4) <u>Biological Control</u>. Biological control methods (herbivorous fish and insects, pathogenic microorganisms, and competitive plants) are in various stages of development. Grass carp are now available for effective control of watermilfoil. It may be several years before other biological agents (e.g., insects) have been thoroughly tested and approved for use.

(5) <u>Integrated Control Methods</u> (use of 2 or more simultaneous or consecutive treatments) have shown some success in the APMP. In general, these have included use of mechanical harvesting combined with beach-front use of bottom barriers or local herbicide application with wider-spread mechanical harvesting. It is anticipated that biological methods of control will be possible to combine with other methods to further increase program effectiveness. The scientific method of integrated vegetation management, which involves application of herbicides and other control methods at critical periods of the plant's life cycle to achieve optimal control is still regarded as being in development and thus is not expected to be available to APMP sponsors at this time.

1.03 Scoping and Public Concerns. The notice of intent to prepare a supplement to the EIS and the scoping letter for preparation of the draft EISS identified a number of issues which required additional evaluation. Primary issues identified were effects of bottom tillage methods on cultural resources; effects and timing of rotovation on water quality and fi. , collection of watermilfoil fragments after mechanical harvesting; effects of loss of habitat on juvenile salmonids; effects of grass carp on anadromous fish and herbivorous waterfowl; controls against fertile grass carp escape; concern about effects to bald eagles; information on fate and persistence of the herbicides endothall and fluridone, length of effectiveness; effects of herbicides on humans and fish; and evaluation of new techniques, including interspecific competition and integrated control methods.

Principal respondents to the notice of intent and the scoping letter were the Advisory Council on Historic Preservation; U.S. Fish and Wildlife Service; U.S. Departments of the Interior and Transportation; Washington State Departments of Community Development, Ecology, Fisheries, and Interagency Committee for Outdoor Recreation; California State Department of Water Resources; Chelan County PUD No. 1; Cowlitz County Department of Community Development; King County Parks, Planning, and Resources Department; Okanogan County Planning Department; city of Bellevue; METRO: Municipality of Metropolitan Seattle; city of Tacoma; Evans-Hamilton, Inc.; Water Environmental Services, Inc.; Upper Columbia United Tribes Fisheries Research Center; and the Western Washington Toxics Coalition.

SECTION 2. ALTERNATIVES

2.01 Introduction. Three alternatives were identified for the APMP EISS. The first alternative considered is a continuation of treatment options described in the EIS (1979). The second alternative is the recommended action which updates treatment options described in the original EIS (1979), but includes more emphasis on rotovation; consideration of one additional herbicide (fluridone); consideration of new information on another herbicide (endothall); decreased emphasis on 2,4-D; continued nonencouragement of diquat, and dichlobenil; and impact analyses for two new treatment sites (Pend Oreille River, Pend Oreille County, and Swofford Pond, Lewis County). The third and final alternative considered is discontinuation of the program (or no action), in which no Federal assistance for the treatment of watermilfoil would occur.

2.02 Alternative 1: Continuation of Management Practices Described in the 1979 EIS. Treatment methods given extensive review for possible use in the 1979 APMP EIS are briefly summarized here. Discussion from the EIS is incorporated by reference. (Incorporation by reference is described in 40 CFR 1502.21 and allows linking of publicly-available documents to minimize restating past analyses and conclusions. This EISS indicates where conclusions vary or analyses supplement the EIS.)

a. Mechanical Harvesting. The common mode of growth for watermilfoil is a sediment-embedded root system and root crown, from which the stems and leaves emerge. Mechanical harvesting cuts and removes submerged aquatic vegetation above the root crown (at or below the sediment surface) and at water depths up to 8 feet below the surface. Because root crowns are not affected, plants may re-grow. Watermilfoil can be spread by vegetative fragmentation; any branch tip has the potential to regenerate roots to create a new, viable plant. Vegetative fragmentation also occurs naturally, without harvesting. Unfortunately, harvesting can speed such dispersal, even with the use of containment booms. Therefore, mechanical harvesting should be applied in areas in which do not require complete eradication and where fragmentation will not greatly increase the rate of spread. An expense associated with harvesting is the cost of disposal of watermilfoil fragments. Mechanical harvesting is not usually watermilfoil-specific and affects all aquatic vegetation.

b. Rotovation. Rotovation tills up to approximately 8 inches below the bottom sediment surface to dislodge stems and roots which then float to the surface. Depending on the time of year and amount of affected biomass, dislodged plants and roots are sometimes removed for upland disposal. Rotovation is usually done before or after the growing season to assure that dislodged plants will not reestablish roots. The decision whether upland disposal should occur is based on (a) consideration of the potential for vegetative spread; and (b) consideration of the potential for vegetation to rot or shoal and thereby impact navigation, recreation, fish and wildlife, or accumulation trash racks of dams. Rotovation causes disruption of bottom organisms and should be used only when complete removal of the plant is required. Rotovation is not very watermilfoil-specific either.

c. Suction Dredge. The suction dredge is a small barge or boat equipped with compressors and suction hoses used by divers to remove individual watermilfoil plants, including roots. Plants are carried through hoses to a basket on the barge in order to separate plants from water and sediment. The water and sediment are discharged back into the water. The suction dredge is feasible for small areas which require complete watermilfoil removal, are too large for hand removal, and cannot be treated with herbicides. At this time, no commercial contractors involved in suction dredging exist in Washington State.

d. Bottom Barriers. Bottom barriers were composed as of 1979 were composed of polyvinyl chloride-coated fiberglass screens which limited sunlight penetration to aquatic plants in affected areas. Because of their high cost and maintenance, the employment of screens is justified only in high-use areas where exclusion of all aquatic growth is acceptable. New materials are now available that improve cost-effectiveness and performance.

e. Fragment Barriers. Barriers can be used to stop downstream spread of floating watermilfoil fragments in water systems which flow directly into uninfested waters. Barriers consist of a floating boom with fine mesh net extending 3 to 4 feet below the water surface. Due to low demonstrated effectiveness, further funding for fragment barriers is not anticipated.

f. Hand Removal. watermilfoil can be controlled in shallow shore zones by handpulling or raking by workers or divers.

g. 2,4-D. Several formulations of the chemical 2,4-dichlorophenoxyacetic acid, a systemic herbicide which translocates throughout and thus affects the whole plant, with a high degree of selectivity for watermilfoil, kill roots as well as upper plants. 2,4-D does not affect most native species at label-specified treatment concentrations. However, recent decisions by EPA have made 2,4-D unavailable to the APMP at this time.

h. Endothall (Dipotassium salt), Dichlobenil, and Diquat. Diquat and endothall are contact (as opposed to systemic) herbicides which kill exposed leaves and stems of aquatic plants but do not affect plant roots. Dichlobenil is systemic and could kill roots. None of these three chemicals are selective to watermilfoil so would also kill non-target species of aquatic plants. Accordingly, they are recommended for very limited use, primarily in areas where the exclusion of all aquatic growth is acceptable. These chemicals could kill terrestrial plant species if irrigation water is inadvertently treated.

i. Integrated Control. Integrated control is the use of two or more control techniques, such as mechanical harvesting followed by chemical treatment and, although developmental, may be effective in some situations.

j. Biological Control. Herbivorous fish, insects, and plant pathogens are being researched for future use in the treatment of watermilfoil. However, at present the only biological control method which is fully tested is the white amur, or grass carp. No others are currently available for use to treat watermilfoil in Washington.

2.03 Alternative 2: Proposed Action (Update of Treatment Options).

a. Treatments.

(1) Mechanical Harvesting. Mechanical harvesting remains the same as described in the APMP EIS. Early reports indicated that some long-term control of watermilfoil could be accomplished from multiple harvests conducted over several years; however, practical experience in the Pacific Northwest suggests that these reports were overly optimistic. The Municipality of Metropolitan Seattle, METRO, has been harvesting watermilfoil since 1980 in Lake Washington and Lake Sammamish and there are still substantial watermilfoil problems in the harvested areas.

(2) Rotovation. Recent experiences in Canada and Washington State indicate that rotovation is one of the most effective methods for watermilfoil treatment. In the experience of the Canadians, rotovation provides higher control than harvesting at a lower cost at sites in British Columbia. Efforts to perfect the machinery and techniques have eliminated several early drawbacks to this method. The Canadian program now uses two float-mounted rotovators as prime elements in their management program. Tractor-mounted and amphibious rotovators were inefficient over the range of depths and conditions required for satisfactory watermilfoil control. Float-mounted rotovators presently used are mechanically reliable and provide good control in waters 3 to 12 feet deep. In water less than 3 feet deep, the rotovator head tends to "walk" across the bottom, leaving many roots intact. A cultivator can be used in shallow water together with the deeper water rotovator to provide good control of watermilfoil.

Various treatment patterns were evaluated to overcome difficulties in coverage due to poor water visibility which occurs during rotovation (Bryan and Armour 1982). The patterns studied included parallel to shore, perpendicular to shore, and circular. The first two methods did not consistently provide an acceptable level of control so were rejected. The circular pattern was performed with the machine tethered to the center of the circle, and the tether lengthened with each revolution by an amount slightly less than the width of the rotovator head. This provided excellent coverage, but due to the extra time and effort involved, this method was also rejected. Subsequently, a criss-cross pattern achieved by making passes parallel and perpendicular to the shore has proven effective, providing excellent coverage.

The Canadian program uses rotovation early in the growing season (February-May) when watermilfoil has not achieved a large biomass. This reduces the possibility of heavy accumulations of plant material on the tiller head which decreases machine efficiency. Furthermore, early rotovation produces fewer fragments than treatments performed at the peak of the growing season. Rotovation treatments are also performed from October to December, as the fragments produced probably do not survive the winter. Using these techniques, rotovation has demonstrated immediate and short-term control.

Rotovation cannot normally take place during the early stages of watermilfoil colonization in quickly flowing rivers used for spawning by salmonids. In British Columbia, the Ministry of Fisheries used rototilling (similar to a

garden rototiller) to restore watermilfoil-infested gravel spawning beds. Rototilling is performed in spawning channels where the water can be temporarily shut off upstream and the channel drained dry. This form of rotovation has not yet been used in Washington, but suggests a possible means of habitat restoration/enhancement.

METRO has evaluated the efficiency of a derooting machine similar to a rotovator (Mesner et al., 1985). A float-mounted bar is lowered 4 to 5 inches into the sediment and drawn toward the boat to deroot plants. This machine is effective at removing the entire plant, and the harvesting bar is detachable and interchangeable with wider or narrower bars. The principal problem noted with the bar derooter is the collection of fragments produced.

(3) Suction Dredge. Suction dredging remains acceptable as stated in the 1979 EIS; however, no commercial contractors are presently available.

(4) Bottom Barriers. Bottom barriers are highly effective in preventing watermilfoil growth. Bottom barriers appear highly functional in areas not accessible to conventional harvesters, such as very shallow waters, crowded spaces around docks, and protected swimming areas. Effectiveness of the screens is more closely related to physical contact with the substrate and space limitation instead of light inhibition of the watermilfoil (Harmon and Amundsen, 1980).

Early problems associated with the use of bottom screens and barriers, such as the accumulation of gas bubbles which cause buoyant lift and movement of the material, have been solved through the refinement of techniques and materials. A general survey of methods, materials, and costs was produced by Truelson (1984a) (table 2-1). Effectiveness of specific materials in Canadian waters was discussed by Truelson (1984b). After evaluating Texel, Dartek, Aquascreen, window screen, and burlap, he recommended Texel and Dartek for sites where routine maintenance can be performed and long-term control is desired. Burlap was recommended for situations where low-cost, short-term control is preferred. Additionally, Wright (1984) provided a useful review of the characteristics, effectiveness, and costs of burlap as a bottom barrier material.

University of Washington researchers working in Lake Washington observed only minor changes in dissolved oxygen levels while testing the effectiveness of Aquascreen, and concluded that water quality impacts are minor (Perkins, 1980; Perkins et al., 1980). They concluded that 3 months of coverage by Aquascreen did not adversely impact the abundance or composition of the invertebrate benthic community. Contradictory results were observed by Engel (1984) who found that the benthic community in a Wisconsin lake was reduced by two-thirds after 3 months under Aquascreen.

The cost of cleaning bottom barriers, required about every 2 years, is about $0.107/ft^2, (about $4,660/acre) or $2,330 per acre per year.

TABLE 2-1

BOTTOM BARRIERS AVAILABLE TO CONTROL NUISANCE AQUATIC PLANTS
(FROM TRUELSON, 1984b)

Material Construction	Cost[1] Per Acre	Buoyancy	Effectiveness[2] Average Period of Control	Characteristics
I. NATURAL FABRIC				
Burlap -woven jute fiber	$2,100	negative 1-3 years	++	Biodegradable (2 years). Fragment roots can attach to upper surface and penetrate barrier
II. POROUS SYNTHETICS				
Polyvinyl Chloride (woven) -close woven PVC coated rayon	$1,975	negative	untested	
"Texel" -needle punched polyester fabric (#7606)	$3,490	negative 2-3 years	+++	Rot resistant Fragment roots have difficulty attaching to surface, penetrating barrier
"Typar" -spun bonded polypropylene fabric	$3,040	positive	++ 2 years	Must be ballasted with sand or gravel which provides a rooting substrate
Window screen -vinyl coated fiberglass mesh	$4,980	negative	++ 2 years	Mesh allows some plants to grow through from below and fragment roots can attach above

Material Construction	Cost[1] Per Acre	Buoyancy	Effectiveness[2] Average Period of Control	Characteristics
III. NONPOROUS SYNTHETICS[3]				
"Dartek" -black nylon film with slit perforations	$2,460	negative	++ 2 years	Perforations allow covered plants to grow through barrier
"Milrol" (polyethylene) -common black plastic- 6 mil	$730	positive	+ 2 years	Must be ballasted with sand or gravel which provides a rooting substrate; must be perforated to allow gas escape
Polyvinyl Chloride -industrial grade black plastic-10 mil	$2,100	negative	++ 2-3 years	Must be perforated at intervals to allow gas escape; some penetration by covered plants will occur

1/Costs in 1984 U.S. dollars.

2/All but one of the materials has been tested in British Columbia lakes for control of watermilfoil. A similar (or possibly better) level of control would be expected in treatment of other aquatic plants. The effectiveness rating is based on field testing using the following criteria: susceptibility to recolonization by rooting fragments (determines period of control), degree (if any) of penetration by covered plants, and the durability/longevity of the materials.

Ratings: +++ very effective
++ effective
+ partly effective
- not effective

3/All nonporous barriers must be perforated to allow gasses from decomposing plants to escape, otherwise, the panels will be lifted to the surface.

(5) Fragment Barriers. Fragment barriers remain the same as outlined in the 1979 EIS; however, they have proven ineffective.

(6) Hand Removal. Handpulling remains an approved method of treatment.

(7) 2,4-D. 2,4-D (2,4-dichlorophenoxyacetic acid) formulations (butoxyethanol ester and dimethylamine salt) are currently unavailable for aquatic treatments in our region while the Environmental Protection Agency (EPA) is reconsidering health risk information of this herbicide. Until a final decision is made on the herbicide's safety, it will not be included as an option for watermilfoil control. About March 1988, 2,4-D were listed as a possible human oncogen (tumor-causing agent) by EPA.

(8) Endothall (Dipotassium salt). Endothall (7-Oxabicyclo (2.2.1) heptane-2,3-dicarboxylic acid) is a species-nonspecific contact herbicide which does not translocate in the plant; it thus kills only contacted leaves and stems, but not roots, of aquatic plants. It is more effective when used with an agent that can break through the plant's exterior waxy coat. In field studies (Corps, 1984), endothall was effective in reducing the population and biomass of watermilfoil as well as other native aquatic macrophytes, specifically *Potamogeton richardsonii*, *P. crispus*, *Zannichellia palustris*, *Ceratophyllum* sp., and charophytes. In another study, Killgore (1984) reported that endothall takes longer to cause die-back, results in earlier regrowth, and in general is less effective than 2,4-D and diquat in reducing watermilfoil and *P. crispus*.

Endothall appears to be an effective treatment method for watermilfoil at application concentrations of 3 ppm or less, especially when applied with an inverting oil or polymer which causes it to cling to and penetrate the plant. It is recommended for limited use, primarily in areas where the short-term depression of some native species is acceptable. The submersed aquatic vegetation may regrow within the same season following application of potassium salts of endothall (Corps, 1984). Information developed by METRO (Appendixes A and B) indicated low levels of concern for non-amine formulations of endothall to aquatic life (the APMP has suggested use of the dipotassium salt, not the amine-formulation). Moreover, a recent update of endothall's human health effects suggests caution should be taken to exclude swimmers from endothall-treatment water following application (Appendix B-4).

(9) Dichlobenil. Dichlobenil is a systemic herbicide which kills leaves, stems, and roots. It is not encouraged for control treatment, as outlined in the EIS.

(10) Diquat. Diquat, a contact herbicide, is licensed but is not approved by the State of Washington for aquatic use unless the applicant has total control of the treatment site. It is not encouraged for the APMP.

(11) Fluridone (Sonar). Fluridone (1-methyl-3-phenyl-5-(3-(trifluromethyl)phenyl)-4(1H)-pyridinone) is the only new herbicide considered at this time for potential use in the APMP. It is absorbed from water by plant shoots

and from sediments (hydrosoils) by roots, and works by inhibition of chlorophyll production in plants (EPA 1986). It is a systemic herbicide which appears to provide excellent control of aquatic plants beginning 2 to 3 weeks after application and lasting as long as 13 weeks (McCowen et al., 1976). The herbicide is effective at very low concentrations (0.25 to 1.0 ppm - McCowen et al., 1979; 0.01 to 0.02 ppm continuous release - Hall et al., 1984). Fluridone requires a longer contact time than other herbicides, which limits its usefulness in flowing water. It is best applied prior to initiation of weed growth or in early, active growth in spring. In liquid suspension, Sonar may be applied as a surface spray to the water, under the water surface, or along the bottom of the water body. Recent research in the APMP suggests that application at less than one-half the label rate is still quite effective. Most suitable application systems for flowing waters use a liquid formulation blended with adjuvants, which are sticky fluids such as inverting oils and polymers, or fibers, which enhance clinging to submersed vegetation (Getsinger and Westerdahl, 1988). No direct comparisons could be found on fluridone's effectiveness versus other herbicides; however it does appear to be more effective than other herbicides at low concentrations (1.0 ppm or less).

Hall (1984) and West et al. (1987) found in laboratory tests that continuous environmental concentrations of fluridone at 0.01 ppm reduced plant root biomass by 53 percent and plant stem biomass by 84 percent. At continuous concentrations of 0.02 ppm fluridone, root biomass diminished 79 percent and plant biomass 90 percent. The plant biomass decrease began approximately 8 to 16 days after treatments were initiated at environmental concentrations of 0.01 - 0.09 ppm.

Fluridone persistence in hydrosoil should be considered in proposed treatment programs. Since fluridone can be absorbed from the hydrosoil by roots, and since fluridone persists in the hydrosoil for extensive periods of time, impacts to vegetation may occur long after treatment. Fluridone residues reached a maximum in hydrosoil 14 days after treatment (Grant et al. 1979). No detectable residue at a detection level of 0.010 ppm was observed in hydrosoil after 62 days. In a later study of two ponds in Indiana, the residue pattern was similar (using two different methods) in both ponds, with no detectable residue remaining 56 days after treatment (West and Parka 1981). Muir and Grift (1982) found that the half-life of fluridone in artificial ponds under field conditions was 17 weeks and 12 months under laboratory conditions. No detectable residues were observed in hydrosoil after one year in ponds and lakes in three geographic regions in the U.S. and in Panama (West et al. 1979).

In the laboratory, Marquis et al. (1982) studied degradation of fluridone in submersed sandy and silt loam soils under controlled conditions. The laboratory conditions eliminated photolysis and plant uptake, the normal mechanisms for fluridone removal from hydrosoil, but allowed microbial metabolism. Thirty percent of the fluridone still remained in the soils after 12 months under artificial conditions.

The fate and persistence of fluridone in surface water is of considerably less concern. There are no label restrictions against drinking, swimming, or fishing in water treated with fluridone (EPA 1986).

Primarily, fluridone breaks down due to light (photolysis) in water and soils (West et al. 1983). Fluridone is stable to oxidation and hydrolysis (McCowen et al.

1979), and volatilization is not significant. A photolysis half-life of 5.8 days for fluridone was observed in flasks containing pond water (Muir and Grift 1982). Numerous investigators have measured the half-life of fluridone in surface water with a range of results. Hall et al. (1984) and Dow-Elanco Company stated that the apparent half-life of fluridone in water is 14 days or less. Fluridone aqueous half-lives ranged from 5 to 60 days in a study by West et al. (1983), from 4 to 7 days in a Canadian pond study (Muir et al. 1980), and from 2 to 3.5 days in another Canadian pond study (Muir and Grift 1982). Weed Science Society of America (1983) stated that fluridone has a half-life of 21 days in water when used for control of aquatic vegetation. West and Parka (1981) observed two ponds using two methods of detection and found that the rate of fluridone dissipation from water was similar in both ponds. The half-lives of fluridone were 21 and 26 days after surface application and application along the pond bottom. They concluded that the method of applying fluridone to the pond did not appear to affect herbicide dissipation from the aquatic environment. Grant et al. (1979) observed that fluridone began to dissipate from the water in 3 to 14 days after treatment, while Kamarianos et al. (1989) observed that fluridone levels in a pond populated with carp decreased to below detection limits after 60 days. In the latter study, fluridone decreased in the water at a high rate during the first days after application, and no fluridone was detected after two months, results similar to Langeland and Warner (1986).

The long contact time for fluridone for effectiveness as an herbicide requires consideration during its application. Fluridone is not as effective in flowing waters as in impounded waters because it is slow-acting. Accordingly, researchers have been studying methods to prolong its contact with the weeds. Van and Steward (1985) found that use of fibers for controlled delivery of fluridone in moving water could extend the contact period. In their study, fluridone release lasted over 40 to 50 days (no detectable fluridone levels were determined after 42 days using 0.8 and 1.2 mm fibers). Dunn et al. (1988) packaged fluridone in fibers that became trapped in aquatic plants. They achieved fairly constant release rates from several days to four months.

Drift of fluridone into non-treatment areas may also occur depending on the chemical formulation and oil or polymer vehicle used, and on currents in the treatment area. Thus, fluridone should be cautiously used in areas with currents. (See also sections on Public Water Supply and Habitat.)

There are no label restrictions against drinking, swimming, or fishing in water treated with fluridone. Fluridone is degraded primarily by photolysis, by biodegradation, and least significantly by volatilization (Westerdahl and Getsinger 1988). Thus, there is no reason for restriction of fluridone in ground water (EPA 1986).

The risk to human health due to the use of fluridone is assessed in Section 4.0.2d (6)(c) and Appendix B. Available toxicology data were used to calculate an acceptable dose. The maximum acceptable concentration (MAC) in the water was determined based on expected human ingestion rates of water or aquatic organisms. The MAC was compared to the estimated environmental concentration (the concentration in a water body calculated from herbicide application rates and persistence data). If the estimated environmental concentration is less than the MAC, no increased risk to human health is expected. The calculation of an acceptable dose (at which no adverse effects are expected to occur) assumes that the herbicide is not

MAC, no increased risk to human health is expected. The calculation of an acceptable dose (at which no adverse effects are expected to occur) assumes that the herbicide is not carcinogenic, and fluridone has been determined by EPA not to cause cancer. Estimated initial water concentrations did not exceed either the water supply MAC or the incidental ingestion MAC for adults or children. Also, estimated initial concentrations did not exceed calculated MACs for fluridone for the dermal exposure route and the ingestion of aquatic organisms. Fluridone is not irritating to the skin, and only minor effects were noted after application of undiluted fluridone to the eyes of rabbits. Thus, no adverse effects are expected from contact with dilute solutions.

(12) Integrated Control. Integrated control (as used in the APMP) consists of two or more different techniques which together produce greater control than either method singly, or provide the same control efficacy for less effort. Greater control results in a more rapid watermilfoil decline, or a longer time for watermilfoil to regrow and reach nuisance levels. Among the three types of control methods (chemical, biological, and mechanical), there are a large number of potential combinations for integrated control.

There is also a more scientifically-rigorous concept of integrated pest management that includes principally herbicides and biological control agents used in concern at critical life-stages of the pest, or weed. Application of integrated pest management to watermilfoil is still developmental. Scientists at the Corps' Waterways Experiment Station (WES) are working to test promising integrated pest management methods for the next few years. Integrated chemical and biological control methods are currently being investigated in other parts of the country to determine feasibility and efficiency (Cassani and Caton, 1985; Shireman et al., 1983).

Meantime, the APMP has successfully attempted several integrated control (broad sense) applications. In Washington State, a study to investigate the possibility of establishing spikerush (*Eleocharis coloradoensis*) following the control of watermilfoil with 2,4-D was conducted in 1986 and showed mixed results (Gibbons and Gibbons, 1987). In shallow areas planted with large, densely populated strips of cut sod, spikerush was successful in surviving and reproducing; in areas planted with strips composed of small wet plugs, it was not. Wave and water circulation patterns in the vicinity of the beds played a major role in transplant success.

Combinations of mechanical techniques such as harvesting and bottom barriers have been effectively used in Lakes Washington and Sammamish. For small lakes, it is anticipated that combinations of harvesting or grass carp and bottom barriers may be the least-cost treatments in future. Also, limited-area herbicide application and harvesting is potentially useful.

Although watermilfoil may outcompete native vegetation and spread throughout the available habitat once introduced to a body of water, interspecific competition is an effective weed control method in some situations. A long-term study is being conducted on Buffalo Lake in Okanogan County to determine interactions between watermilfoil and several other aquatic macrophyte species (Broch and Loescher, 1984). Determining specific conditions which enable native plant species to outcompete watermilfoil will be a significant step towards a successful integrated

control program.

(13) Biological Control. Researchers at WES and at national and international academic institutions have been searching for years for safe, effective biological control agents for Eurasian watermilfoil. Plant pathogens, herbivorous fish, and herbivorous insects show the greatest promise, but further laboratory and field research need to be conducted before any (excepting the herbivorous fish) are generally available for use.

Plant pathogens. Preliminary research suggests that the use of plant pathogens may be productive in the future. Several topics require more research, such as the establishment of inoculation strategies and inoculum thresholds and determining the optimum time in the life cycle of watermilfoil for initiation of infection. The future use of plant pathogens may be particularly effective in conjunction with mechanical techniques or with organisms that physically damage plant tissues, thus providing inoculation sites (Gunner, 1983).

Herbivorous fish. White amur, or grass carp (*Ctenopharyngodon idella*) are quite effective in reducing aquatic plant biomass depending on the size of the fish, the species of plant, and water temperature. Mature grass carp can eat several times their weight in plants per day under optimum conditions. A relatively high feeding rate by grass carp is a result of their short intestinal tract and low digestion rate (10 to 30 percent); thus, they kill more plants than a more efficient assimilator. Release of nutrients from partial digestion has never been observed to result in algal blooms in the field, although it is theoretically possible (Harmon and Amundsen, 1980).

Researchers at the University of Washington are completing a research program which investigated the feasibility of using sterile triploid grass carp to control watermilfoil (Pauley et al., 1988). Since 1984, Ecology, the Corps, and the U.S. Fish and Wildlife Service have provided funds to continue this research, which includes a literature review, laboratory analyses, and field trials at several Washington State lakes which have no public access and lack a means for grass carp to escape. Currently, availability of a sterile carp greatly improves the chance of the fish becoming a biological control agent for watermilfoil in Washington State. Most previous studies used fertile diploid grass carp and were conducted in warm water. Concern has been expressed that the introduction of nonnative fish may disrupt native aquatic communities by uncontrolled reproduction; however the use of sterile triploid hybrids rules out this possibility, depending on the effectiveness of methods for verifying that the fish are indeed triploid. Introductions of nonnative species such as grass carp require the certification of the Secretary of the U.S. Department of Interior and fish transfer permits from the Washington State Department of Wildlife. As part of the University of Washington studies, reliable methods to verify triploidy in shipments of imported carp were developed and reported to journals for peer review. Verification of the sterility of triploid carp has been completed.

As of this writing, triploid grass carp has been approved for use in Washington subject to certain conditions which are still developing at present. Potential sponsors interested in this alternative should obtain the most recent version of conditions from the State of Washington Department of Wildlife.

The goal of researchers at the University of Washington was to learn how triploid grass carp behave in northwest waters (which are colder than their native habitat) in order to predict stocking rates which would maintain aquatic plant growth at an acceptable level while maintaining water quality, wildlife, and native fish populations. Feeding preferences of triploid grass carp for common aquatic plants in Washington State have been determined and show (in descending order) that Potamogeton crispus, P. pectinatus, P. zoster, Elodea canadensis, and Vallisneria spp. are highly preferred; Myriophyllum spicatum, Ceratophyllum demersum, Utricularia vulgaris, and Polygonum amphibium are variably preferred; and that Potamogeton natans, Brachiaria schreberi, and Elodea densa are not preferred. Chemical properties of the plants affect preference. The ability of triploid grass carp to control aquatic plants in small lakes is being evaluated in field trials that will be completed in 1992. Impacts to water quality, resident fish populations, and invertebrate communities have been evaluated in the study lakes. Land (1981) observed carp and waterfowl competing for the same food items in Lake Conway, Florida, leading to lower numbers of overwintering waterfowl. Incidental observations by University of Washington researchers indicate there will be some competition between carp and waterfowl for preferred food items. Current research focuses on regulation methods to adjust stocking rates.

Herbivorous insects. Researchers from British Columbia have observed several species of aquatic insects grazing on watermilfoil (Kangasniemi and Oliver, 1983). Of those observed, Cricotopus myriophylli shows most promise. Preliminary results indicate that this insect effectively reduces the height of watermilfoil plants by feeding on meristematic (cell division and active growth) regions, and that Myriophyllum spicatum is preferred over M. exalbescens (a native watermilfoil species). C. myriophylli seems particularly promising as a biocontrol agent because it is native to the Pacific Northwest (British Columbia), although it has yet to be identified and isolated in Washington State. Research is needed to determine how to produce or sustain populations of the insect to attain effective control. Additional research on life history of the insect and watermilfoil is being conducted in British Columbia to determine when the plant is most vulnerable to attack by the insect.

b. Areas.

(1) Pend Oreille River. The Pend Oreille River between Box Canyon Dam and the Idaho border was added to the program in 1982.

(2) Swofford Pond. Swofford Pond on the Cowlitz River, Lewis County, was added to the program in 1988.

(3) Okanogan. The Okanogan-Columbia Rivers near Malott, Washington, were treated from 1981 to 1983 but are no longer proposed for treatment.

2.04 Alternative 3: No Action Plan. The no-action plan is the termination of all Federal assistance in the control of watermilfoil. If untreated, watermilfoil could continue to spread throughout the State, including the Cowlitz/Columbia Rivers, and into Lake Pend Oreille, Idaho. Isolated water bodies could also continue to become infested as a result of inadvertent transport of watermilfoil via recreational traffic among lakes and reservoirs. In the absence of the APMP, the boater and recreationalist education and signage programs would be terminated.

Attached or floating masses of watermilfoil could hamper navigation and continue to be costly to remove from beaches and trash-racks of dams. The presence of watermilfoil in irrigation systems could interfere with water flow in irrigated areas of the State, such as the Yakima Valley and Columbia Basin. Native plant species would be excluded by watermilfoil, and fish and wildlife habitat would be damaged. In the no-action alternative, watermilfoil could continue to cause disruption to human recreation such as swimming, boating, and fishing. Finally, the lack of assistance in funding of treatments could cause an economic hardship on local sponsors.

It is possible based on experiences in other cool climates that severe watermilfoil infestations would naturally decline due to slow establishment of adapted communities (e.g., insects such as Cricotopus myriophylli) in Washington State without the APMP. However, estimates for a natural decline range from 15-40 years after infestation of a particular area, and new areas are currently suffering from spread of the weed.

2.05 Comparative Impacts of Alternatives. Status of optional and future control methods under Alternative 1 (Continuation of the 1979 EIS), Alternative 2 (Proposed Action: Update of Treatment Options), and Alternative 3 (No-Action Plan) are compared (table 2-2). Impacts of all three alternatives are presented (table 2-3) to assist decisionmakers and reviewers by summarizing and comparing major impacts.
In reading the table, it should be understood that the conclusions indicate programmatic recommendations only. The no-action alternative is the probably future with no further Federal cost-sharing programmer Federal environmental involvement in watermilfoil treatment. In this future, it is possible that (for example) mechanical harvesting could still occur, but it is assumed that it would be negligible since the cost-sharing program would not exist. "OK to use" or "not encouraged for use" similarly represent programmatic status according to current information and knowledge. It is possible that the EISS could conclude "OK to use" but a local jurisdiction could conclude otherwise (e.g., METRO's policy to discourage herbicides and pesticides). Accordingly, "OK to use" really means "the Corps concludes that this treatment is environmentally suitable for consideration in the cost-sharing program subject to State of Washington and local restrictions."

TABLE 2-2

STATUS OF CONTROL METHODS UNDER ALTERNATIVES 1, 2, AND 3

	ALTERNATIVE #1 Continuation of the 1979 FEIS	ALTERNATIVE #2 Proposed Action: Update of Treatment Options	ALTERNATIVE #3 No Action Plan
MECHANICAL HARVESTING	OK to use. Limited to areas which do not require complete control.	OK to use. No change.	No mechanical harvesting.
ROTOVATION	OK to use. Impacts not well known. Should be used only when complete plant removal is required.	OK to use. Recent experience indicates that it is one of the most effective methods for milfoil treatment.	No rotovation.
SUCTION DREDGE	OK to use. Used in small areas which require complete milfoil removal, are too large for hand removal, and cannot be treated with herbicides.	OK to use. No change	No suction dredging.
BOTTOM BARRIERS	OK to use. Suggested for high use areas.	OK to use. No change.	No bottom barriers.
FRAGMENT BARRIERS	OK to use. Used to stop downstream spread of milfoil fragments in flowing waters, but relatively ineffective.	OK to use, but ineffective. No change.	No fragment barriers.
HAND REMOVAL	OK to use. Used in shallow shore zones.	OK to use. No change.	No hand removal.
2, 4-D	OK to use. This herbicide has a high degree of sensitivity for milfoil.	On hold pending EPA decision.	No application.
ENDOTHALL, DICHLOBENIL, DIQUAT	OK to use. Not selective for milfoil. Suggested for limited use in areas where the exclusion of all aquatic growth is acceptable.	Endothall (K salt) is OK for limited use (State of Washington advises caution in use of endothall). Dichobenil is not encouraged for use. Diquat is available for limited use.	No application.

TABLE 2-2 (Continued)

STATUS OF CONTROL METHODS UNDER ALTERNATIVES 1, 2, AND 3

	ALTERNATIVE #1 Continuation of the 1979 FEIS Treatment Options	ALTERNATIVE #2 Proposed Action: Update of	ALTERNATIVE #3 No Action Plan
FLURIDONE (SONAR)	Not considered.	OK to use. Not selective for milfoil.	No application.
INTEGRATED CONTROL	OK to use. EIS concluded it is effective in some situations, but expensive.	OK to use. Several programs in APMP have shown worthwhile combinations of treatments. Research is ongoing in chemical/biological treatments.	Research would continue but not under the Aquatic Plan Management Program.
BIOLOGICAL CONTROL	Being researched for future use.	Plant pathogens, herbivorous fish, and herbivorous insects are being researched. Limited use of white amur (grass carp) is permitted.	Research would continue but not under the Aquatic Plant Management Program.

TABLE 2-3

COMPARISON OF MECHANICAL, CHEMICAL AND BIOLOGICAL METHODS FOR MILFOIL CONTROL

		CHEMICAL METHODS		INTEGRATED METHODS	BIOLOGICAL METHODS		
		ENDOTHALL Dipotassium Salt	FLURIDONE Sonar	INTEGRATED CONTROL	PLANT PATHOGENS	HERBIVOROUS FISH	HERBIVOROUS INSECTS
FRAGILE OR SENSITIVE ECOSYSTEMS	+	None	None	Depends on the combination of treatments selected.	None	None	None
	-	Is a non-selective herbicide that will destroy many non-target species, eliminating habitat and cover for a variety of aquatic organisms. Drift may affect non-target areas.	Affects a variety of aquatic plants. Drift may affect nontarget areas. Fluridone can remain at detectable levels in the sediment for over 1 year.	Depends on the combination of treatments selected.	Possible unforeseen adverse interactions with native species.	Possible unforeseen adverse interactions with native species. Not selective for watermilfoil, but watermilfoil is preferred.	Possible unforeseen adverse interactions with native species. (Presumably, a native insect would be tailored for use.)
POTABLE AND IRRIGATION WATER SUPPLY	+	Will reduce clogging on intake structures.	Will reduce clogging on intake structutes. Can use treated water immediately.	Depends on the combination of treatments selected.	May not have water use restrictions.	May not restrict water use.	May not restrict water use.
	-	Cannot use treated water for 7-21 days after application.	Treatment should be at least 1,300 feet from potable water intake in a reservoir.	Same as above.	None	Algal blooms could possibly occur following nutrient release by grass carp.	None
FISHERIES AND WILDLIFE	+	Non-biaccumulative. Concentration after application is below the toxicity of most fish, mammals, and birds.	Low bioaccumulation. Concentration after application is below the toxicity of most fish, mammals, and birds.	Depends on the combination of treatments selected.	Non-toxic to fish and wildlife.	None	Potential food source for other aquatic organisms.
	-	Toxicity to some species is unknown. May have chronic effects with repeated use.	Toxicity to some species is unknown. May have chronic effects with repeated use.	Same as above.	May adversely affect existing fish food sources.	Possible unforeseen adverse interactions with existing species of fish. Some competition between carp and waterfowl for preferred food items.	May adversely affect existing fish food sources.

TABLE 2-3 (Continued)

COMPARISON OF MECHANICAL, CHEMICAL AND BIOLOGICAL METHODS FOR MILFOIL CONTROL

		CHEMICAL METHODS		INTEGRATED METHODS	BIOLOGICAL METHODS		
		ENDOTHALL	FLURIDONE	INTEGRATED CONTROL	PLANT PATHOGENS	HERBIVOROUS FISH	HERBIVOROUS INSECTS
		Dipotassium Salt	Sonar				
EFFECTIVENESS	+	Very effective in milfoil control. Growable potential.	Appears to be effective at low concentrations.	OK to use. Several combinations have shown promise in Washington. Research is ongoing for both methods.	Effectiveness being being investigated through research in southeast U.S.	OK to use. Limited by permit condition determined by Washington Dept. of Wildlife.	Still in research stage. Effectiveness is being investigated and shows some promise.
	-	Contact herbicide, kills stems only. Plants will grow back in 6 months to a year.	Requires a longer contact time than other herbicides, limiting its usefulness in running water.				
NAVIGATION	+	Elimination of large weed beds would improve navigation.	Elimination of large weed beds would improve navigation.	Elimination of large weed beds would improve navigation.	Elimination of large weed beds would improve navigation.	Elimination of large weed beds would improve navigation.	Elimination of large weed beds would improve navigation.
	-	None	None	None	None	None	None
HUMAN TOXICITY	+	Does not cause cancer. Low to medium risk is expected from incidental ingestion or from consumption of organisms from treated areas.	No increased risk to human health is expected to occur. No risk is expected from incidental ingestion of organisms from treated areas.	None	Non-toxic to humans.	No known risk.	No known risk.
	-	During first 20 days after application, use of treated water could cause toxic effects. Swimming could lead to skin irritation.	N-methylformamide (NMF) is a breakdown product of fluridone (but has never been detected following treatment under actual field use conditions.	None. Depends on methods (could be chemical treatment involved).	None	No known risk	No known risk

TABLE 2-3 (Continued)

COMPARISON OF MECHANICAL, CHEMICAL AND BIOLOGICAL METHODS FOR MILFOIL CONTROL

		CHEMICAL METHODS		INTEGRATED METHODS	BIOLOGICAL METHODS		
		ENDOTHALL Dipotassium Salt	FLURIDONE Sonar	INTEGRATED CONTROL	PLANT PATHOGENS	HERBIVOROUS FISH	HERBIVOROUS INSECTS
HYDROPOWER	+	Decrease of biomass would probably decrease overall maintenance (applies to all large scale treatments).	Decrease of biomass would probably decrease overall maintenance (applies to all large scale treatments).	Decrease of biomass would probably decrease overall maintenance (applies to all large scale treatments).	Decrease of biomass would probably decrease overall maintenance (applies to all large scale treatments).	Decrease of biomass would probably decrease overall maintenance (applies to all large scale treatments).	Decrease of biomass would probably decrease overall maintenance (applies to all large scale treatments).
	-	None	None	None	None	None	None
COST		$300-500/acre	$240-480/acre Recent studies have suggested that a fraction of this cost can be achieved in small, noncirculating water bodies.	Estimated on a project basis.		$100-650/acre	Still in research stage. No cost estimates are available.

TABLE 2-3 (continued)

		MECHANICAL HARVESTER	ROTOVATION	SUCTION DREDGE	BOTTOM BARRIER	FRAGMENT BARRIER	HAND REMOVAL
FRAGILE OR SENSITIVE ECOSYSTEMS	+	No disruption of substrate. No impact to non-target area.	No impact to non-target area.	Very selective in treatment area and somewhat selective in plant removal.	Very selective for treatment area.	Selective for dislodged plants. Prevention of down-stream infestation of milfoil.	Very selective for treatment area.
	-	Non-selective. Eliminates habitat for a variety of organisms.	Non-selective. Disruption of substrate. Eliminates habitat for a variety or organisms.	Non-selective loss of vegetation in turbid waters.	Disruption of benthic communities.	None	None
POTABLE AND IRRIGATION WATER SUPPLY	+	Minimum disruption of water quality.	None	None	No disruption of water quality.	No disruption of water quality.	No disruption of water quality.
	-	None	Temporary turbidity following treatment. May release bound pollutants from sediments.	Temporary turbidity to small areas during treatment.	None	None	Temporary turbidity to small areas during treatment.
FISHERIES AND WILDLIFE	+	No chronic impacts.	No chronic impacts.	No chronic impacts.	No chronic impacts.	No chronic impacts.	No chronic impacts.
	-	Non-selective loss of aquatic vegetation. Some direct kill of small fish during harvesting.	Non-selective loss of aquatic vegetation. Adverse effect to benthic community will affect benthic feeders.	Slight impact due to increased turbidity.	Non-selective loss of aquatic vegetation.	Possible disturbance to swimming birds and mammals.	Slight impact due to increased turbidity.

TABLE 2-3 (continued)

		MECHANICAL HARVESTER	ROTOVATION	SUCTION DREDGE	BOTTOM BARRIER	FRAGMENT BARRIER	HAND REMOVAL
EFFECTIVENESS	+	Very effective in removal of weed stems to a depth of 8 feet.	Operates in deeper waters than other mechanical methods.	Successful use in rocky areas and near obstacles. Useful for small areas.	Barriers are re-usable. Useful for small, confined areas and near obstacles. Localized impact.	80 to 90 percent effective in stopping watermilfoil fragments in flowing water systems.	Useful for confined areas, rocky areas, and near obstacles.
	-	Regrowth to surface possible with 1 month. Causes spread of fragments. and stimulates plant growth. Need to dispose plant material on shore.	Need to dispose plant material on shore, depending on timing and local situation. Not effective on some sustrates. Not effective in areas with many obstructions.	Regrowth possible in 1 to 2 years. Slow and labor intensive.	Anchoring may be difficult. Subject to lifting by gas bubbles.	Very limited in scope.	Very limited in scope. Labor intensive. costly.
NAVIGATION	+	Improves navigation.	Improves navigation.	Improves navigation.	Improves navigation.	None	Improves navigation.
	-	Could interrupt navigation routes during treatment.	Could interrupt navigation routes during treatment.	Could interrupt navigation routes during treatment.	None	Could interrupt navigation routes.	None
HUMAN TOXICITY	+	None	None	None	None	None	None
	-	None	None	None	None	None	None
HYDROPOWER	+	Removal of vegetation from water would decrease floating mats which could clog water intakes	Removal of vegetation from water would decrease floating mats which could clog water intakes.	None	None	None	None
	-	None	None	None	None	None	None
COST	+	630/acre	600-1200/Equipment Cost, $110,000	800-900/acre (may be a pattern of availability)	9,580-13,940/acre	N/A	Costs dependent upon situation. Labor intensive and expensive.

SECTION 3. AFFECTED ENVIRONMENT

3.01 Introduction. A description of the environment of Washington State was summarized in the 1979 EIS and included reports of the climate, soils, life zones, and water quality for both eastern and western Washington, and is incorporated here by reference. This information, along with descriptions of specific treatment sites (Lake Washington, Lake Samammish, Lake Osoyoos, and the Okanogan River), provided a basis for assessing impacts of the alternatives. Descriptions of two new treatment sites, the Pend Oreille River and Swofford Pond, are included in this section.

3.02 Significant Resources of Lake Washington, Lake Sammamish, Lake Osoycos, and the Okanogan River. Significant physical, biological and ecological, historic and prehistoric, and socioeconomic features of Lake Washington, Lake Sammamish, Lake Osoyoos, and the Okanogan River were described in detail in the 1979 EIS.

3.03 Significant Resources of the Pend Oreille River. The Washington portion of the Pend Oreille River was added to the program in 1982. The Pend Oreille River is part of the Clark Fork-Pend Oreille River basin and flows through Pend Oreille County in the northeast corner of Washington State (figure 3-1). The river flows westward from Lake Pend Oreille in Idaho into Washington, then northward into British Columbia where it joins the Columbia River. Several small towns are located along the river. The State Environmental Policy Act EIS published in 1985 for the Ponderay Newsprint Company-Proposed Facility near Usk, Washington, describes many aspects of the region and is incorporated by reference in this EISS.

a. Physical Features.

Air Quality/Atmosphere. Average temperatures in the Pend Oreille River valley vary seasonally from 75°F in summer (July) to 25°F in winter (January) with a mean annual temperature of 44°F. Continental influences are strongest during the summer and result in semiarid conditions in the valleys. Continental influences in the winter result in comparatively heavy snowfall as warm, moisture-laden air masses from the Pacific Ocean are cooled while passing over mountain ranges of the Clark Fork-Pend Oreille basin. Frequent showers occur in the mountainous regions. Above-freezing temperatures persist in Pend Oreille County for approximately 80-120 days per year; the first killing frost occurs about August 30th and the last killing frost occurs about May 30th.

Water Quality/Supply/Hydrology. Average annual precipitation for Pend Oreille County is 12-48 inches and falls approximately 120 days during the year. Mean annual snowfall is 60 inches, and the latest date of 6 inches or more snow usually occurs during February or March.

Pend Oreille River levels are controlled by Albeni Falls Dam on Lake Pend Oreille, Idaho, and by Box Canyon Dam. The river averages 20,000 cfs per year (range: 4,000 to 140,000 cfs) with peak discharge occurring during May and

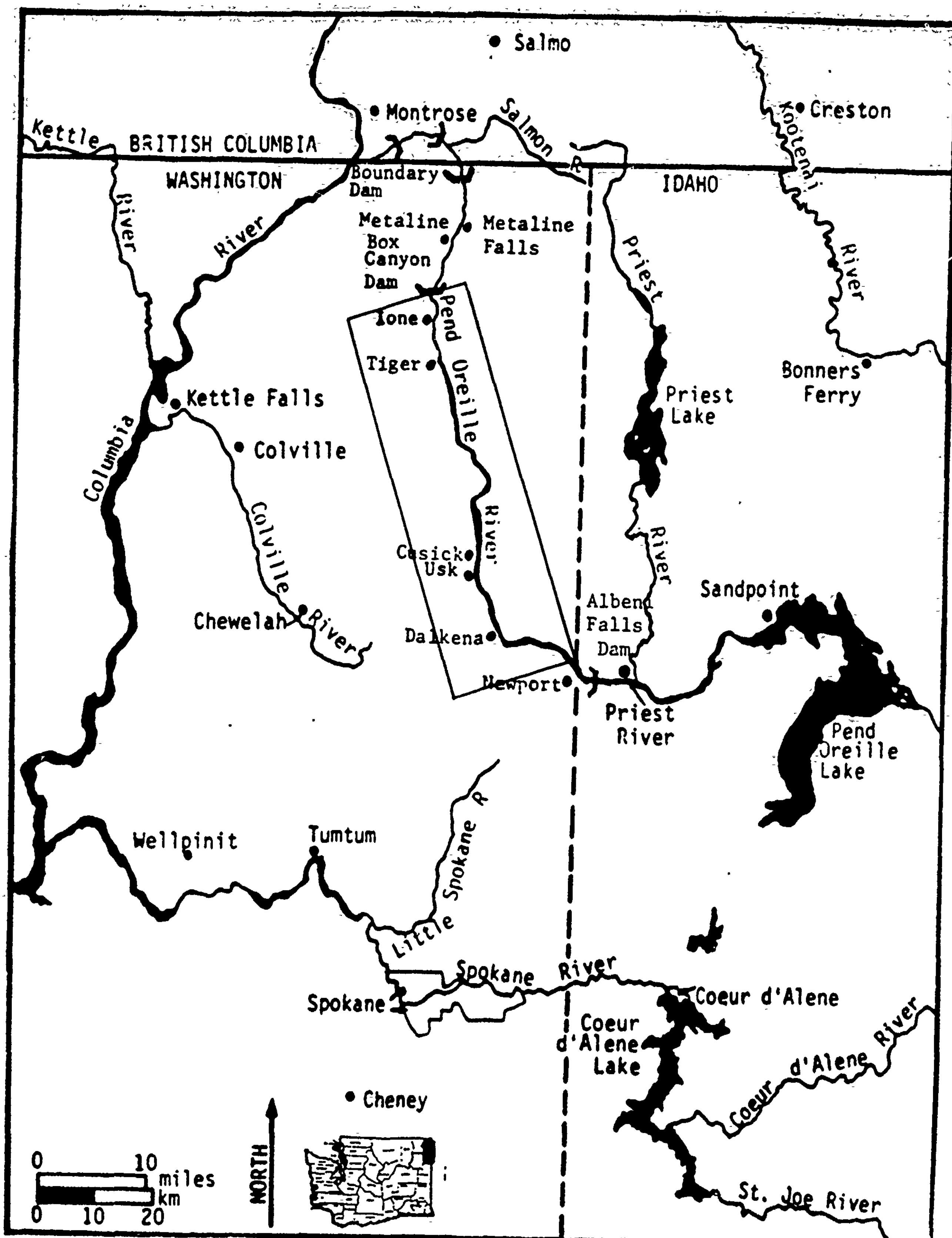

Figure 3.1. Map showing the Pend Oreille River Site for Treatments in the APMP.

June and with low flow in July and August. The river is clear with low sediment content and turbidity for most of the year. During spring floods caused by rapid melting of the snow pack, runoff increases the sediment load. Summer storms are frequently intense but do not occur over large areas or produce floods. Water quality is generally good; however, localized releases of wastewater cause occasional high bacteria and suspended solid concentrations. Due to natural deposits of zinc, lead, copper, silver, and uranium, metal concentrations in the river are sometimes higher than anticipated for a nonindustrial area.

The Pend Oreille River from Pend Oreille Lake to Metaline Falls covers about 86 miles with a low gradient broken only at Albeni Falls Dam and Box Canyon Dam. However, the slope changes abruptly at Metaline Falls; in the 27-mile reach from Metaline Falls to the confluence with the Columbia River, the Pend Oreille River falls 645 feet (390 feet of which are in the river's last 16 miles in Canada).

There is presumed to be ground water movement away from the Clark Fork-Pend Oreille Basin at the south end of Pend Oreille Lake into the Spokane and Little Spokane Rivers through an underlying glacial formation.

Topography/Geology/Soils. The Clark Fork-Pend Oreille River Basin is a conifer-forested montane region, lying on the westerly slope of the Rocky Mountain system. Its perimeter is defined by the crests of various mountain ranges. Numerous other ranges are contained within the basin. On the east, southeast, and south sides, the Continental Divide, formed by the Rocky and Anaconda Mountains, marks the basin boundary. On the southwest, the crest of the Bitterroot Range marks both the basin boundary and the Idaho-Montana State line for a distance of 200 miles. North of the Bitterroots, the westerly boundary is defined by the divides of lesser ranges, of which the Chewelah Mountains are the most prominent. On the north, the boundary is outlined by the Selkirk, Cabinet, and Flathead Ranges which form a broad U-shaped projection south of the international boundary.

The Pend Oreille River flows along the Newport syncline flanked to the east by the Selkirk Mountains and to the west by the Chewelah Mountains. These mountains are rounded in form and seldom rise above 6,800 feet. Rocks in the Pend Oreille basin lying south of the international boundary present a heterogenous assemblage of both sedimentary and igneous rocks. The rocks range in age from Belt through Cambrian, Ordovician, and Tertiary. The intrusive formations extend over a very wide range of composition from acidic to basic. The preglacial Pend Oreille River probably flowed south from the present lake location, following the present course of the Spokane River. Its course was changed because of glacial erosion in its present valley and deposition in its former valley.

The greater part of soils of Clark Fork-Pend Oreille basin have utility only for timber and grazing because of rough, mountainous terrain; however, limited areas are well suited for farming throughout the basin. Soils of the Clark Fork-Pend Oreille Valley exhibit a great variety in origin, situation, and characteristics. Light colored and light textured soils predominate on uplands and on upper benches above the flood plain, whereas darker, heavier types are found most frequently in low-lying, poorly drained bottom or lower bench areas. Upland soils are more extensive, but only those with clay subsoils which have the ability to hold water can be planted with crops continuously and successfully without irrigation. Upland soils which were originally covered by coniferous forests are not very

fertile, but those that have supported prairie grasses are highly productive when supplied with adequate moisture. Dark colored soils occur in small, widely distributed areas. These soils have high natural fertility and high organic content but often require artificial drainage and flood protection.

Mineral Resources. Mineral resources in Pend Oreille County include silica and silicate sand, molybdenum, iron, copper, zinc, lead, gold, limestone, pyrite and feldspar.

b. Biological/Ecological Features.

Vegetation/Habitat Types. Coniferous trees are principally western white pine, ponderosa pine, and lodgepole pine; western larch; Douglas fir; western hemlock; and western redcedar. Important shrubs are snowberry, bitter cherry, mountain maple, sawberry, spirea, redstem ceanothus, snowbush, rose, western serviceberry, syringa, thimbleberry, ocean-spray, Pacific ninebark, willows, and mountain ash.

Submerged macrophyte species reported in the Pend Oreille River (Gibbons et al., 1983a, 1983b, 1984; Layser, 1980) include coontail (*Ceratophyllum demersum*), elodea (*Elodea canadensis*), duckweed (*Lemna* spp.), northern watermilfoil (*Myriophyllum exalbescens*), Eurasian watermilfoil (*M. spicatum*), whorled watermilfoil (*M. verticillatum*), variable pondweed (*Potamogeton gramineus*), western pondweed (*P. latifolius*), floating pondweed (*P. natans*), longleaf pondweed (*P. nodosus*), sago pondweeed (*P. pectinatus*), red-head grass (*P. richardsonii*), flatstem pondweed (*P. zosteriformis*), and white water buttercup (*Ranunculus aquatilis*).

Plant Species and Ecosystems of Concern. No plant species listed by the U.S. Fish and Wildlife Service (USFWS) as rare, threatened, or endangered are reported from waters included in the APMP (Evans-Hamilton, Inc., 1986; Haas, 1991). In response to a request by Evans-Hamilton, Inc., during contract work for the Corps, the USFWS reported that nine candidate species under review for possible inclusion in the list of endangered or threatened species occur in the vicinity of waters included in the APMP. None are aquatic, but some may occur along the banks of waterways.

The Washington Department of Wildlife's Washington Natural Heritage Program has records of five "proposed sensitive" plants found at nine locations within the areas encompassed by the APMP (Evans-Hamilton, Inc., 1986; Hass, 1991). The "proposed sensitive" status is given to taxa that are not currently labelled endangered or threatened but have small populations or localized distributions within the state that may be jeopardized if current land use practices continue. Along the Pend Oreille River, Purple Meadow-Rue (*Thalictrum dasycarpum*) is recorded and recently confirmed from the riparian zone at three locations, Least Bladdery Milk-Vetch (*Astragalus microcystis*) is recorded and recently confirmed from one riverbank location, and Many-Headed Sedge (*Carex sychnocephala*) is recorded in a river-margin slough.

Fish. Game fish associated with the Pend Oreille River and tributaries in the Ione/Tiger area are rainbow, brook, cutthroat, lake trout, as well as yellow perch, walleye, and smallmouth bass. Non-game fish include Columbia squawfish, shiners, and Columbia River chub.

Wildlife. Big game animals include white-tailed deer, mule deer, elk, black bears, mountain cats, bighorn sheep, and mountain goats. Upland game birds include ruffed, spruce, and sharptailed grouse; ring-necked pheasants; and mourning doves. Fur animals include marten, mink, beaver, muskrat, weasel, raccoon, and skunk. Waterfowl inhabiting the area include tundra swan, Canada geese, mallard, greenwinged teal, American wigeon, wood duck, gadwall, pintail, scaup, bufflehead, shoveler, redhead, canvasback, common goldeneye, and ruddy duck. Other bird species inhabiting the area include hawks, eagles, and osprey, the latter of which have been observed nesting along the river between Newport and Metaline Falls.

Animal Species and Habitats of Concern. The bald eagle and the spotted owl are the only endangered species of wildlife along the Pend Oreille River, according to the US Fish and Wildlife Service.

c. Historic and Prehistoric Features.

Prehistoric and Historic Resources. The Pend Oreille River has many flood plain terraces and other landforms that were permanently submerged when Box Canyon Dam was completed in 1955. A cultural resource inventory was not completed prior to building this dam because such work was not required when the non-federally built dam was licensed.

Shortly after the dam permanently raised the pool, part of the area was inspected and eight significant cultural resource sites were located along the river banks between Jared and the Usk bridge (Smith, 1958). Other inventory results from similar terrain along nearby parts of the Pend Oreille River also suggest that the flooded lands probably had numerous prehistoric and early historic cultural activities that left identifiable traces which are now archeological sites (Smith, 1958; Thoms and Burtchard, 1986). Data suggest that not all inundated lands have equal potential for cultural resources.

A limited cultural resource investigation was completed by the Corps in July 1988, resulting in the recording of locations of 37 previously unrecorded prehistoric archeological sites (Salo, 1988a, 1988b).

Native American Concerns. The Pend Oreille River valley and Pend Oreille Lake were homelands of the Kalispel (or Pend d'Oreille) Indians. The Kalispel consisted of two separate tribes, the Upper and Lower Kalispel, who resided along the Pend Oreille River and Pend Oreille Lake, respectively. The Upper Kalispels moved to Flathead Lake, Montana, to join the Confederated Salish and Kootenai Tribes of the Flathead Reservation, whereas the Lower Kalispels moved to the Kalispel Indian Reservation that occupies the east bank of the Pend Oreille River near Cusick, Washington. A trout hatchery is operated on the Reservation. In 1985 the Kalispel Indian Community membership numbered 259 (Ruby and Brown, 1986).

d. Socioeconomic Features.

Land and Water Use. Water use in the basin includes hydroelectrical power, irrigation, navigation (for transporting timber), recreation, and support of fish and wildlife. There are three hydroelectric plants on the U.S. portion of the Pend Oreille River: Boundary, Box Canyon and Albeni Falls Dams. A small portion

of potential agricultural land is irrigated. A newsprint mill near Usk began operations in 1989.

Small grains and hay are the main crops raised on agricultural lands along the river. Private duck refuges, Kalispel Indian lands, the Colville and Kaniksu National Forests, and the railroad system parallel the river.

Population. The Pend Oreille River basin is a sparsely populated 3,100 square-mile area of forested mountains and valleys in Idaho, Montana, and Washington.

Towns along the river in Washington include Newport, Dalkena, Usk, Cusick, Tiger, Ione, Metaline and Metaline Falls, all having populations under 1,000 with the exception of Newport which has a population of about 1,600.

Total county population in 1987 was 8,900.

Economics/Employment. The economy of Pend Oreille County is based on a variety of economic sectors, including forest products/timber, mining, agriculture, tourism and governmental agencies. Agriculture, mining, and recreation are key economic elements.

The recreational aspect of the basin economy is firmly integrated with its characteristic forest and mountain areas. Four public recreation facilities for camping, boat launching and picnicking along the Pend Oreille River are maintained by the U.S. Forest Service.

Transportation. The Pend Oreille River is approximately 50 miles north of the major population center of Spokane, Washington. Transportation through Pend Oreille County is generally via U.S. Interstate 2 from Spokane to Newport then State Route 20 and 31 to British Columbia. Other two-lane all-weather roads parallel the Pend Oreille River. Commercial airports serve Spokane. Airports or landing facilities are available at Newport, north of the Kalispel Indian Reservation, Ione, and east of Metaline Falls. Rail lines parallel the Pend Oreille River from Newport to Metaline Falls. Commercial navigation consists primarily of logs which are towed or floated by the current.

Energy. A major electric transmission line runs through Pend Oreille County starting in the north at the Boundary substation south to the G. H. Bell substation. The Clark Fork-Pend Oreille Basin is interconnected for local power consumption and for Washington power companies to the west, Idaho power companies to the south, and Montana power companies to the east. These interconnections bring most of the power to the transmission grid of the Northwest Power Pool, which comprises most of the private and public power organizations in the five Northwest States.

Social Well-being/Community Cohesion. Major problems perceived by residents in Pend Oreille County include unemployment, low income, lack of development capital, poor use of resources, poor housing, and lack of rental housing (Kiser, 1984, in Ponderay Newsprint Company-Proposed Facility Near Usk, Washington, SEPA EIS, 1985). However, residents also expressed interest in preservation of the county's rural ambience. Most county residents are in agreement that economic development

is necessary if done with due consideration for environmental and lifestyle issues.

Members of the Kalispel Tribe are a distinct group whose heritage involves a close relationship with their land and with the Pend Oreille River. While economic opportunities are of importance to the tribe, they desire that such opportunities preserve other aspects of their lifestyle and heritage.

Esthetics. Pend Oreille County provides natural scenery and opportunities for outdoor recreational activities such as mountain climbing and fishing. The majority of lands are in Natural Forests and Wilderness Areas under Forest Service administration.

Tourism. Visitor use of existing outdoor recreational opportunities in Pend Oreille County is moderate to moderately high from mid to late summer. Although the range of recreational opportunities within the county is high, destination resorts are not available and most visitors either camp when they visit or pass through the area on the way to developed resorts.

Campground facilities in the vicinity, including Corps campgrounds on Pend Oreille Lake, are abundant and of good quality. Four National Forest campgrounds (Brown's Lake, South Skookum Lake, Pioneer Park and No Name Lake) are open from Memorial Day to Labor Day. There are also a number of dispersed, undeveloped campsites in the Colville and Kaniksu National Forests. Camp Spaulding, located on Davis Lake about 6 miles south of Usk, is a private church camp. A state campground is located at North Skookum Lake and additional campsites are located in Pend Oreille County Park.

3.04 Significant Resources of Swofford Pond. Swofford Pond, a 240-acre shallow lake located in Lewis County, Washington, empties into Riffe Lake, the reservoir formed by Mossyrock Dam on the Cowlitz River system (figure 3-2). Swofford Pond is an artificial lake originally used as a steelhead rearing pond to mitigate for steelhead losses due to construction and operation of Mossyrock Dam by the city of Tacoma, Washington. Several years after pond construction in 1966, IHN (a viral disease affecting steelhead) precluded use of the pond and Riffe Lake as a fish rearing area. The pond subsequently became a high-use spiny-ray warmwater fishing pond which is stocked by the
Washington Department of Wildlife and managed as an important recreational area. Five years ago, watermilfoil became a problem in the pond and negatively affected fish and recreation. This is perhaps the first watermilfoil outbreak in Lewis County and there is growing concern that watermilfoil could migrate into Riffe Lake, Mayfield Lake, and the Cowlitz River from fragments propagated from Swofford Pond. Fluridone treatment of Swofford Pond was conducted in a pilot study for the APMP, with a high degree of effectiveness.

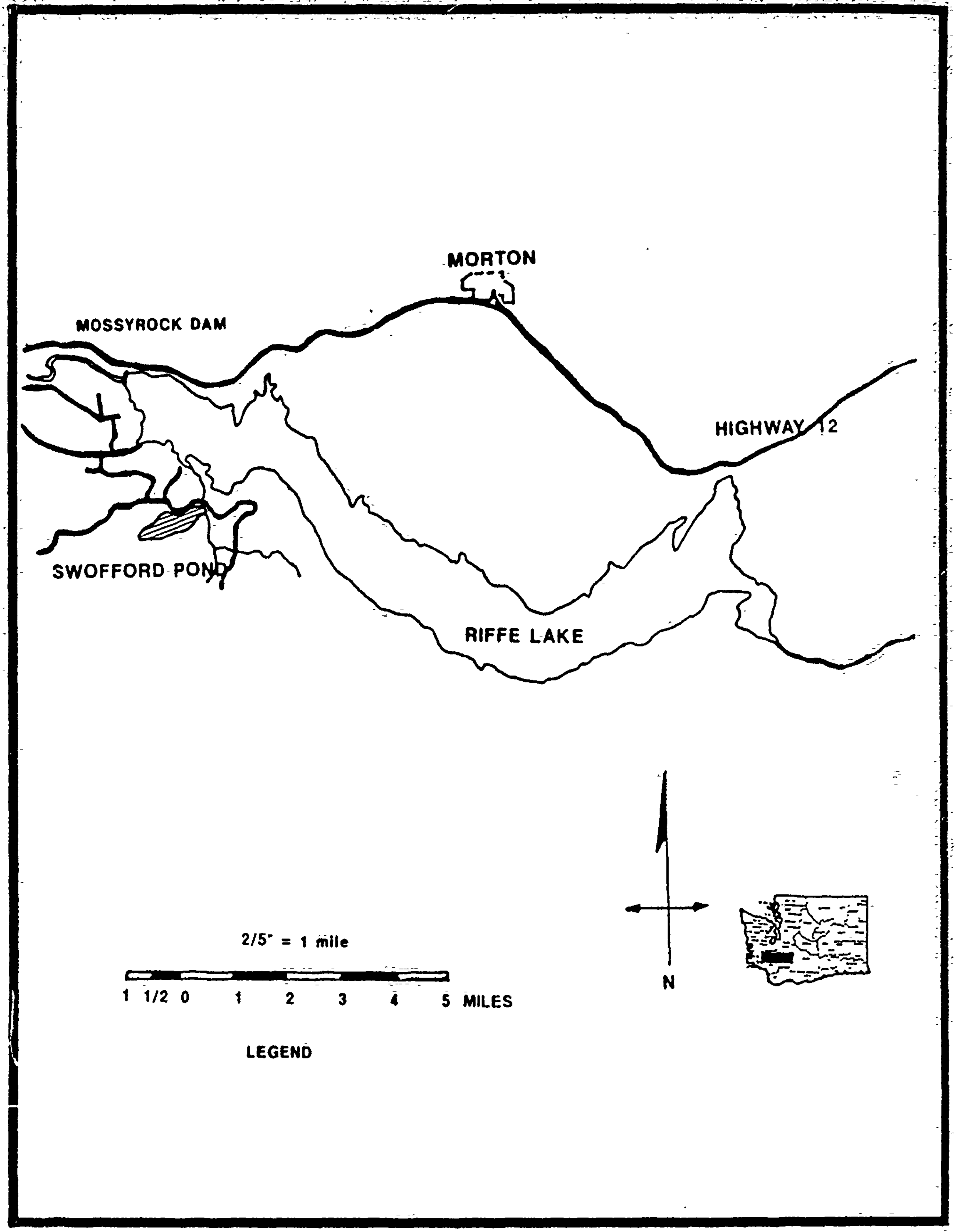

Figure 3.2. Map showing the Swofford Pond Treatment Site for the APMP.

a. Physical Features.

Air Quality/Atmosphere. Average temperatures in the area vary seasonally from 70°F in summer (July) to 40°F in winter (January) with a mean annual temperature in the area of 44°F. Above freezing temperatures persist for approximately 140-180 days during summer; the first killing frost occurs about October 30 and the last killing frost occurs about April 30.

Water Quality/Supply/Hydrology. Average annual precipitation for the area is 45-60 inches. Mean annual snowfall is 12 inches, and the latest date of 6 inches or more snow usually occurs in January or February.

Water levels in Swofford Pond are governed by a controllable outlet to Riffe Lake. Tributaries of the pond are Sulfur and Mud Creeks which have less than 2 cubic feet per second flow in the summer and average 20 cubic feet per second flow in the winter.

Water of Swofford Pond is soft with a conductivity of 30-50 micromhos.

Temperatures in the pond reach 68°F in the summer months. Swofford Pond is separated from ground water by an impermeable layer (Dr. R. Logan, Department of Ecology, personal communication).

Topography/Geology/Soils. Swofford Pond is part of the Lower Columbia River basin, within the Willamette-Puget Lowland region. Soils are generally silty and sandy, formed in alluvial sediments on bottomlands and low terraces. Colluvial materials from basic rock types are also present in the Riffe Lake area. The area forming the pond was previously a grazing pasture for cattle.

Mineral Resources. Mineral resources in Lewis County include mercury, high-alumina clay, coal, sand and gravel, basalt or volcanic rock and pumice. Sand and gravel are mined near Swofford Pond for construction materials.

b. Biological/Ecological Features.

Vegetation/Habitat Types. Submerged vegetation in Swofford Pond is dominated by watermilfoil (*Myriophyllum spicatum*) and also contains elodea (*Elodea canadensis*) and coontail (*Ceratophyllum* sp.). Emergent vegetation includes reed canarygrass (*Phalaris arundinacea*), cattail (*Typha latifolia*), buckwheat (*Polygonum* spp.), pondweeds (*Potamogeton* spp.), *Carex* spp., scouring-rush (*Equisetum*), bulrush (*Scirpus* spp.), and other species of grasses, reeds, and sedges. Alder (*Alnus rubra*) and some willows (*Salix* spp.) are found along the shoreline.

Plant Species and Ecosystems of Concern. There are no plant species or ecosystems of concern in or near Swofford Pond.

Fish. Swofford Pond contains bluegill, largemouth bass, channel catfish, bullhead, rainbow trout, brown trout, and crappie.

Wildlife. Canada geese, bufflehead, teal, mallard, wood ducks, and hooded mergansers are a few of the migratory birds that have been seen on the pond. Rails and bitterns also use Swofford Pond. In the fall, counts of birds on the

pond have exceeded 3,500 in a single day. Otter, muskrat, mink and beaver den in the Swofford Pond area.

Animal Species and Habitats of Concern. There are no listed occurrences of threatened, endangered, or sensitive species of submerged plants or animals in the pond. Waterfowl, bass, and bluegill may be impacted by the loss of vegetation cover. A bald eagle nest area has been observed approximately ¼ mile from Swofford Pond.

c. Historic and Prehistoric Features.

Prehistoric and Historic Resources. A cultural resources reconnaissance was accomplished prior to creation of the pond. No cultural resource sites are known at the Swofford Pond site.

Native American Concerns. No Native American concerns are known at Swofford Pond.

d. Socioeconomic Features.

Land and Water Use. Swofford Pond is fished as much as 25,000 person hours annually. A gravel boat launch is available. The Swofford Pond area supports approximately 75 trapper and 75 duck hunter days per year.

Land around Riffe Lake is classified as cropland and commercial forest land.

Population. Population in the rural area around Swofford Pond is of low density. Many 5-acre tract homes are in the area, and approximately 40 to 50 homes are within ½ mile of the pond. The closest town is Mossyrock, approximately 6 to 7 miles from Swofford Pond, with a population of less than 1,000.

Economics/Employment. Primary employment is in the logging and farming industries. Tourism is important to the area; Mossyrock Park on Riffe Lake has thousands of visitors each summer.

Transportation. Transportation to Swofford Pond is via Interstate Route 5 to the town of Chehalis, then U.S. Route 12 past Silver Creek. An access road is then taken to Swofford Pond.

Social Well-being/Community Cohesion. Swofford Pond has an important spiny-ray fishery which is considered an asset to the community. The popular and successful program is threatened by watermilfoil.

Esthetics. The area around Swofford Pond is rural, with forests and pastures. Nearby Mayfield Lake and Riffe Lake are beautiful recreational areas, and Mossyrock Park is a tourist destination during summer months.

SECTION 4. ENVIRONMENTAL EFFECTS OF THE FINAL ALTERNATIVES

4.01 Introduction. Information gathered on rotovation and endothall since publication of the 1979 APMP EIS is presented and environmental consequences of fluridone treatment are analyzed in this section. Descriptions of impacts of other methodologies and some of the current ones are discussed in the 1979 EIS. Since 2,4-D, diquat, and dichlobenil are not currently encouraged for treatment, they are not further discussed in this EISS. Impacts to the following environmental elements are discussed: air, noise, traffic, water, soil, energy, plants and animals, historic and prehistoric resources, Native American concerns, and socioeconomics. Relationships of the project to existing water and land use plans, policies, and controls are analyzed.

4.02 Proposed Plan.

a. Direct and Indirect Physical Impacts and Their Significance.

(1) Air Quality, Noise, and Traffic.

(a) Rotovation. Adverse impacts to air quality, noise levels, and traffic caused by rotovator operation are expected to be minor and of short duration. Air quality would be affected by exhaust emissions from the rotovator and from trucks which transport harvested plants to disposal sites. Noise and traffic could be increased as a result of transport vehicles; however, disposal may not be required for spring treatment.

(b) Herbicides. Adverse impacts to air quality, noise, and traffic caused by chemical treatment are expected to be minor and associated with the use of application equipment. A small amount of exhaust emissions and a small increase in noise may occur. No aerial drift or overspray is expected as a result of herbicide applications since they are usually performed with subsurface applicator devices.

(2) Water Supply and Hydrology.

(a) Rotovation. Beneficial effects to water quality are expected as a result of rotovation's removal of plant material from the water and hydrosoil. Removal of harvested watermilfoil eliminates chemicals from the nutrient regeneration process, thus making the nutrients unavailable for future algal and plant growth. This could slow eutrophication of lakes. Biological oxygen demand associated with aquatic plant decay would be reduced due to watermilfoil removal. However, plant removal following rotovation may not always be required.

Rotovation usually occurs in spring, when the biomass of watermilfoil is slight, or it may occur in fall, when biomass is considerable but plants are moribund. Rotovation in the fall could increase the rate of decaying biological materials in the water. If the amount of plant material released into the water is enough to cause problems by decaying, by accumulating in mats that could affect fish or other aquatic life, or by clogging navigation channels or dam intakes, then contract specifications should include provisions for plant removal from the water

body and upland disposal.

Rotovation can cause serious short-term adverse impacts on water quality due to stirring up sediments. Turbidity levels would be increased, and suspended particulates would resettle on benthic organisms and aquatic vegetation. Significant levels of nutrients and other bound chemicals could be released from the sediments to the water where they would be available to aquatic plants and algae.

Although adverse impacts may occur as a result of rotovation, recent studies in British Columbia have demonstrated that impacts have not been as serious as predicted in the 1979 EIS. Nitrogen, phosphorus, and some metal concentrations increased in the British Columbia lakes following rotovation but not to levels that would cause environmentally harmful effects (Bryan and Armour, 1982). Rotovation had very little short-term effect on the water quality of Lake Osoyoos, with the exception of total organic and inorganic Kjeldahl nitrogen, which reached a post-treatment maximum 24 hours after treatment (Gibbons and Gibbons, 1986).

(b) Herbicides. Adverse impacts to water quality may occur after chemical treatment to control watermilfoil. Upon death, watermilfoil begins to decompose, creating a short-term biological oxygen demand and a longer-term increase in organic sediment. Problems with decreased dissolved oxygen levels are not expected because treatment is limited to small areas which provide adequate water exchange from untreated areas.

Increase in levels of organic and inorganic phosphorus may occur in the water column during decomposition of watermilfoil. Phosphorus is often a limiting factor for aquatic plant growth; thus watermilfoil treatment may result in rapid growth of other aquatic plants and algae.

Drift of herbicides into nontreatment areas may occur depending on current, plant uptake rates, and the chemical formulation and suspending agent used. Due to its persistence in sediments, fluridone should be cautiously applied to avoid drift into marginal wetlands. Aquatic systems that may have seasonal overflows into water supplies should not be treated during high water periods. However, this should not be a problem because high river flows and lake levels usually occur in late fall and winter, while chemical treatments are generally scheduled during periods of low flow and low water levels in spring and summer.

Both herbicides considered in this EISS are subject to chemical or biological breakdown and do not persist indefinitely in water, sediment, or aquatic organisms. Half-lives for the breakdown of endothall in the presence of light and oxygen range from 1 to 8 days and for fluridone range from 5 to 60 days (average 20 days). Endothall breaks down in sediments in 1 to 2 months, while fluridone can remain at detectable levels in the sediment more than 1 year. A recent report, (Osborne et al., 1989) states that no detectable residues of N-methylformamide (NMF), the most toxic residue of fluridone, have been found in any water samples collected through 168 days after Sonar treatment. Little information exists on the transfer from sediment to ground water of either of these herbicides. (See Appendix B and Section 2.04a (10) and 4.02d (6)). Note that for fluridone, lower-than-label-recommended application rates are effective for controlling watermilfoil and also would minimize drift.

(3) Topography and Soils. Watermilfoil infestation can reduce current speed in flowing water and increase siltation, thus changing the shape and/or composition of the river or lake bottom. Removal of watermilfoil could temporarily reverse these changes, i.e., result in increased flow rates and reduced siltation.

(a) Rotovation. Rotovation disrupts sediments up to nine inches in depth, thereby changing the shape and composition of lake and river bottoms. Impacts on topography have generally been minor in lakes and slow moving rivers, since displaced hydrosoil will settle near its origin. In higher current situations, finer grained hydrosoils will be displaced down-current while sandy sediments will fall very near the rotovation site. Rotovation experiences in the Pend Oreille River have shown that although the bottom is slightly modified in shape and the grain size is coarser and sandier at first, within 24 hours the bottom becomes indistinguishable from adjacent sediment surfaces as finer sediments are deposited from upstream sources.

(b) Herbicides. Impacts by herbicides on topography and soils include increased flow rates, decreased siltation following watermilfoil removal, and persistence in hydrosoils (of fluridone) following application. See Section 2.03a(10).

(4) Energy.

(a) Rotovation. Energy consumption would be limited to gas and oil used to operate the rotovator.

(b) Herbicides. Energy consumption would be confined to gas and oil used during application of the herbicide, plus energy required to produce and process chemicals used to manufacture the herbicides.

b. Direct and Indirect Biological/Ecological Impacts and Their Significance.

(1) Vegetation/Habitat Types.

(a) Rotovation. Rotovation disrupts of the vascular plant community at the treatment site. Rotovation is generally used to clear a small area within a large watermilfoil bed; thus, recolonization by several species including watermilfoil is expected and usually occurs within 3 to 4 months. Occasionally a species which was dominant before watermilfoil infestation recolonizes. For example, at three sites in Canada, *Potamogeton crispus* regrew to nuisance proportions following rotovation for watermilfoil, and *Potamogeton* spp. were observed in treated plots in Lake Osoyoos after rotovation. Other species that have recolonized following rotovation in Canada were *P. pectinatus*, *P. graminus*, and to a lesser extent, *P. amplipholius*. Regrowth is strongly affected by the kind of sediments at the site (Barko and Smart, 1986); watermilfoil tends to create sediments that favor its own regrowth.

Immediate watermilfoil stem density reductions of 63 to 90 percent occurred over a range of substrate types following 1986 rotovations in the Pend Oreille River. This suggests that root removal efficiency can be high; root removal efficiency is largely a function of equipment operator skill, adequately powered machinery, and

sediment composition. Watermilfoil stem counts from these same areas in 1987 ranged from 25 to 70 percent less than pretreatment counts. This would indicate a carryover effectiveness. Drift accumulation of watermilfoil parts could provide an adverse impact by smothering.

(b) Endothall. Endothall is a contact herbicide killing only exposed parts of plants but not roots or subsurface stems (Leonard, 1982). Endothall is subject to chemical or biological breakdown; it will not persist indefinitely in water, sediments, or aquatic organisms. Endothall exists as amine and potassium (K) or sodium (Na) salt formulations, which may behave somewhat differently. Ambient concentrations for both endothall formulations in the water column dissipate with a half-life of 1 to 8 days and fall to nondetectable levels in the sediment in 1 to 2 months. Available toxicity data indicate that K and Na endothall salts which readily dissociate to the endothall cation are much less toxic to aquatic organisms than the amine formulation of endothall (tradename Hydrothol 191) (see also section 4.02.b(2)). In general, the amine formulations are not included for use in the APMP.

Vegetation treated with endothall begins to die in a short time, although usually two treatments are needed for the maximum effect. Decomposing vegetation may reduce dissolved oxygen concentrations by biological decomposition, but probably not to anoxic or toxic conditions in flowing or standing water due to small treatment areas relative to size of the water body. Bound nutrients in vegetation are released into the water during decomposition; these increased nutrient levels may lead to algal blooms or a rapid increase in the growth of other aquatic plants.

Chemical treatment of plant communities dominated by watermilfoil may result in either a shift to other species or in more open habitat with fewer macrophytes. In a study conducted in Lake Washington at a site with an initially diverse plant community, the use of a dipotassium salt of endothall (Aquathol K) at the recommended dosage of approximately 2 ppm endothall acid reduced the biomass of other native aquatic macrophytes, specifically Potamogeton richardsonii, P. crispus, Zannichellia palustris, Ceratophyllum sp., and algal stoneworts (charophytes) (Corps, 1984). In this field study, Elodea canadensis was not adversely affected and became the dominant species at the treatment site. Invertebrates are less abundant on watermilfoil than on other macrophytes, so a community shift to other plant species may result in greater abundance of invertebrates, which would provide more fish food for grazers. Creation of more open water with fewer macrophytes may also increase fish habitat. Alternatively, some juvenile fish use watermilfoil communities as a refuge area from predators and as general habitat (Killgore et al., 1987); this would be lost with chemical treatment. Small fish looking for refuge probably use the edge and not the entire watermilfoil stand. Also, Ecology suggests retaining 20 to 25 percent of water lilies or similar aquatic vegetation as fish rearing habitat in areas proposed for treatment in the APMP. Accordingly, the impact of loss of refuge area should be slight.

Endothall is applied at or below the water surface; accidental "drift" exposure to upland vegetation during application would be minimal, with the exception of emergent aquatic plant communities bordering the treated area. If any "proposed sensitive" plants or candidate species under review for possible inclusion in the

state list of endangered or threatened species occurs along the banks of waterways to be treated with endothall, the applicator should leave a protective buffer zone between the treated area and the species of concern. Upland plant species could potentially be damaged if treated water was improperly used for irrigation before herbicide degradation occurred. This is not expected to occur because notification of water directors and posting of treatment dates are part of the treatment plan.

(c) Fluridone. Fluridone is a systematic herbicide. It is taken up by aquatic plants and moved within the plant's vascular system to other parts, including submerged portions (McCowen et al., 1976). Like endothall, fluridone is subject to chemical or biological breakdown and will not persist indefinitely in water, sediments, or aquatic organisms. In the sediment, however, fluridone may remain at detectable levels for more than a year. For a discussion of fluridone's persistence in water and soil, see section 2.03a(10).

Fluridone blocks chlorophyll synthesis in aquatic plants, causing chlorosis and death. Noticeable "dying off" or decrease in biomass of vegetation treated with fluridone begins approximately 8 to 16 days after initiation of treatments (Hall et al., 1984). Impacts from release of nutrients following the death of treated plants are similar to those described for endothall (4.02.b(1)(a)). This study also reported that fluridone affects a variety of aquatic plants. Treatment by fluridone may result in community shifts to other plant species as described above (4.02.b(1)(b)).

Due to the long contact time required for effective control, fluridone may be carried away from the application area and may thus treat submerged or broken communities in areas two to five times the size of the "target" area. Thus, drift effects to other vegetation have the potential to be substantial in view of the persistence in hydrosoils (See Section 2.03a (10)). These potential effects are also lessened by the finding that fluridone is an effective control agent for watermilfoil at one-half or less of the label application rate. A further solution to the dispersal problem was developed experimentally by packaging fluridone in fibers which become trapped in aquatic plants preventing drift (Dunn et al., 1988). If any "proposed sensitive" plants or candidate species under review for possible inclusion in the state list of endangered or threatened species occurs along the banks of waterways to be treated with fluridone, the applicator should leave a protective buffer zone between the treated area and the species of concern. Additionally, treated areas in most cases will usually comprise a very small percentage of the lake at any one time. (Swofford Pond was an exception.)

(2) Wildlife and Fish (See Ecological Risk Section, Appendix A).

(a) Rotovation. Although no fish have been observed to be killed or removed by rotovation (Evans-Hamilton, Inc., 1986), fish may be affected by removal of benthic invertebrates or detritus. Juvenile fish use nearshore areas of lakes in early summer to feed; therefore rotovation during spring would be less disruptive to juveniles. In Lake Osoyoos, the benthic invertebrate community did not appear to be disrupted by rotovation (Gibbons et al., 1986).

(b) Endothall. Laboratory toxicity tests of endothall on juvenile chinook salmon (Oncorhynchus tshawytscha) were conducted over periods of 30 minutes to 14 days (Landolt et al., 1981).

- Endothall was toxic to juvenile salmon at concentrations of 62.5 ppm endothall acid and 88 ppm dipotassium endothall (LC_{50} lethal concentration to 50 percent of the test population over 14 days). Normal application rates according to the herbicide label are 1 ppm.

- At concentrations less than 25.54 ppm all fish exhibited normal behavior, and above this concentration all fish exhibited some abnormal behavior.

Results suggest that no significant impacts would occur at recommended treatment concentrations.

During seawater entry tests for coho smolts devised by Lorz and McPherson (1979) and run by Landolt et al. (1981):

- all juvenile chinook exposed to 3 ppm or more endothall acid (4.2 ppm dipotassium salt) died within three days of seawater entry;

- control fish and fish exposed to 1.5 ppm endothall acid (2.1 ppm dipotassium salt) or less endothall successfully adapted to artificial seawater.

Histopathological studies showed that the dead fish had irritated or damaged branchial epithelial cells. A problem with this test is that fish were released from fresh water directly into seawater with no intermediate salinity adjustments like those encountered by natural runs.

In a separate study, coho salmon exposed to 5 ppm endothall for 1 hour were injured; however, injuries were reversed and all fish successfully passed the seawater entry test when fish remained in clean freshwater for 4 days after exposure (Bouck and Johnson, 1979).

Thus, irritation caused by endothall is reversible for some exposure concentrations. For most fish species, LC_{50}s range from 100 to 200 ppm (Evans-Hamilton, Inc., 1986).

Estimated environmental concentrations (EEC) for endothall salts expected to occur in the water after application at the recommended rate are 1.00 ppm (Final Acute Value, Final Residue Value, and Criterion Maximum Concentration), and 0.06 ppm

(Final Chronic Value and Criterion Continuous Concentration) (as defined in appendix A.II.b.1).

(c) Fluridone. Fluridone has a very low order of toxicity (McCowen et al., 1979; Arnold 1979). LC_{50} of fluridone for bluegill and rainbow trout are 14.3 and 11.7 ppm respectively. Field observations of aquatic life (bluegill, bass, catfish, crayfish, frogs, and water snakes) indicated no observable adverse effects from the use of 0.1 to 1.0 ppm fluridone. Zooplankton and phytoplankton populations were depressed slightly when 1.0 ppm was applied; this response should not cause any significant environmental problems (Evans-Hamilton, Inc., 1986). Estimated environmental concentrations (EEC) for fluridone expected to occur in the water after application at the recommended rate are 0.13 ppm (Final Acute Value, Final Residue Value, and Criterion Maximum Concentration), and 0.08 ppm (Final Chronic Value and Criterion Continuous Concentration) (as defined in Appendix A.II.b.1.). Fluridone appears to be easily carried away from the application area; however, the release rate can be adjusted by controlling the loading of fluridone in fibers which become trapped in aquatic plants, solving the dispersion problem (Dunn et al., 1988).

(3) Threatened and Endangered Species, Other Species, and Habitats of Concern.

(a) No plant species federally listed as rare, threatened or endangered are reported from the waters included in the APMP (U.S. Fish and Wildlife Service, 1991). Nine candidate species, under review for possible inclusion in the state list of endangered or threatened species, occur in the vicinity of waters included in the Aquatic Plant Management Program. None are aquatic, but some may occur along the banks of waterways. They are Carex comosa, Astragalus misellus v. pauper, A. sinuatus, Phacelia lenta, Delphinium viridescens, Petrophytum cinerascens, Trifolium thompsonii, Artemisia campestris v. wormskjoldii, and Lomatium serpentinum.

Three State "proposed sensitive" plants are found at locations within Pend Oreille County, which is encompassed by the APMP (National Heritage Data System, 1985). The "proposed sensitive" status is given to taxa that are not currently labeled "endangered" or "threatened" and have small populations or localized distributions within the state that may be jeopardized if current land use practices continue. Along the Pend Oreille River:

- Purple meadow rue (Thalictrum dasycarpum) is recorded and recently confirmed from the riparian zone at three locations;
- Least bladdery milk vetch (Astragalus microcystis) is recorded and recently confirmed from one riverbank location; and
- Many headed sedge (Carex sychnocephala) is recorded in a river margin slough.

The APMP recommended treatments, if applied with cautions indicated, should not affect plant species under review by the U.S. Fish and Wildlife Service or species considered "proposed sensitive" by the Washington Natural Heritage Program.

There are no species of plants or animals listed or under consideration for listing at the State or Federal level at Swofford Pond, with the exception of bald eagles.

(b) Bald eagles are the only federally listed "threatened" species of wildlife confirmed to be present along the Pend Oreille River according to the U.S. Fish and Wildlife Service (Evans-Hamilton, Inc., 1986). The eagles overwinter along the river from approximately 31 October to 31 March and are probably absent from the area during APMP herbicide treatments. They nest there in spring so could be present during mechanical treatments.

In 1988 a pair of bald eagles built a nest within 0.25 miles of the pond and occupied it for 1.5 months. An additional four to five eagles have been observed to forage for bluegills at any time of year in Swofford Pond. G. Oakerman of Washington Department of Wildlife (personal communication) believes that the bluegill population will not drop with watermilfoil eradication; thus foraging eagles will not be affected by herbicide treatment.

Bioconcentration of endothall salts in algae, Daphnia, and fish does not occur (METRO 1986); thus, transfer of endothall through the food web to bald eagles is unlikely. The predicted bioconcentration of fluridone in fish is 0.9-15.5 (METRO, 1986). A value of 100 is usually taken as a significant bioconcentration factor. Thus, these predicted values are too low to be of concern in terms of bioaccumulation, which reflects uptake from water and food, or biomagnification, which represents the increased concentration of a chemical as predators eat prey.

(c) The spotted owl has recently been listed as threatened in Washington. The owl prefers old growth forest, and is out-competed when it tries to live in second growth, by other owls such as Great-horned and barred. Barred owls are present near the Pend Oreille River, and there is little old growth. Thus, it is unlikely that spotted owls occur in the vicinity (although no studies have been conducted to confirm this). Furthermore, should spotted owls be present, their prey base consists primarily of forest rodents and flying squirrels. It is quite unlikely for a spotted owl to come into contact with aquatic species.

c. Cultural Resource Impacts.

(1) Prehistoric and Historic Resources. Rotovation, an underwater bottom tilling method, destroys root systems of watermilfoil during the fall and winter dormant period. Rotovation is of concern for cultural resource management because the technique has potential to inadvertently disturb sites that may occur on landforms such as terraces that were flooded before cultural resources inventories were taken. At the request of the State Historic Preservation Office (SHPO), the Corps prepared a management plan for cultural resources in areas with potential sites which is summarized below.

(a) Lakes Washington and Sammamish, King County, Washington. Rotovation in Lakes Washington and Sammamish will not affect cultural resources as no land has been submerged by these lakes.

(b) Lake Osoyoos, Okanogan County, Washington. Rotovation in Lake

Osoyoos will have no effect on cultural resources that are or may be eligible for the National Register of Historic Places (Salo, 1988a).

(c) Pend Oreille River, Pend Oreille County, Washington. Future rotovation may have adverse effects on only four prehistoric archeological sites on the shores of Box Canyon Reservoir. Before rotovation may take place at these sites, the actual degree and kind of effect must be established, first by confirming that upland archeological site material actually extends into the rotovation tract. This may be done through coring or examining the site surface during drawn-down reservoir conditions. Once a site is confirmed in the impact area, its condition must be established. If the site is eroded and redeposited, no further consideration of it may be required. On the other hand, if the site is intact and will be affected by the rotovation project, further investigation or measures to protect the site may be needed. All project effects may be avoided by not rotovating on the site (Salo, 1988b).

(2) Native American Concerns. The American Indian Religious Freedom Act of 1978 (AIRFA) requires Federal agencies to ensure that none of their actions interfere with the inherent right of individual Native Americans to believe, express, and exercise their traditional religions. These rights include access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonials and rites. The AIRFA requires coordination between Federal agencies and Native Americans to ensure that federally supported projects or projects on Federal land do not infringe on the religious practices of Native Americans.

Coordination between the APMP and potentially affected tribes has occurred throughout the study and is ongoing. Discussions to date have not revealed any concerns with religious practices relative to proposed treatment sites.

Lake Washington has been adjudicated as a usual and accustomed fishing area of the Muckleshoot Indian Tribe, which has expressed concerns for aquatic plant management through herbicide use. Their concerns include immediate and cumulative effects of herbicides to all life stages of all species of anadromous fish, and potential effects to fishermen, fishery habitat and fishing gear. These effects have been considered in Sections 4.02.b. based on information in appendix A. It should be noted that the EISS may consider an herbicide or other method acceptable, but State and local governments make the decision to use it. The Lake Washington portion of the program is administered by METRO, which has a policy to discourage the use of chemicals to control watermilfoil in the King County region.

d. Direct and Indirect Socioeconomic Impacts and Their Significance.

(1) Land Use and Property Values. Dense infestations of watermilfoil could restrict access to recreational areas and could eventually cause waterfront property to lose value. Treatment would reduce these adverse effects.

(2) Population. None of the control alternatives should have any adverse effect on human populations. The primary positive effect would be to maintain an attractive recreational environment, which would influence tourism.

(3) Economics/Employment. The APMP would provide employment or business

to a limited number of weed control companies, chemical manufacturers and retailers, and builders of mechanical harvesting equipment. If untreated, watermilfoil infestations could lead to the loss of income and employment for businesses such as marinas, motels, or recreational facilities, and could negatively affect the developing tourism industry in eastern Washington. In the Usk vicinity of the Pend Oreille river, proposed industrial development which utilizes river water for cooling would be able to go forward without continued concern for warmer water's encouraging excess watermilfoil growth. This will positively affect employment potential in the region.

(4) Public Services and Recreation. Some public recreation facilities and water-related recreation areas have been obstructed by watermilfoil. Treatment could reestablish full use of these areas. Additionally, power generation at dams on the Pend Oreille River and Columbia River has been negatively affected by accumulations of watermilfoil in trash racks. Recreational use could be restricted for short periods of time after rotovation or herbicide treatment.

(5) Navigation. The APMP would have a beneficial impact (and no adverse impacts) on recreational boating by removing watermilfoil obstructions in shallow water.

(6) Public Health. (See Human health Risk Assessment, Appendix B.)

(a) General. The elimination of watermilfoil would reduce stagnant water which fosters mosquito breeding areas and thus could reduce mosquito populations. Mosquitoes are possible carriers of encephalitis in Washington.

(b) Rotovation. Rotovation should not have any effect on human health. However, areas which have sediments with poor settling rates or high concentrations of toxicants should be tested for sediment pollutant levels prior to rotovation because of the potential to exceed EPA water quality criteria in the immediate vicinity of the rotovator.

(c) Herbicides.

(i) Human Health Risk Assessment. The risk to human health due to use of aquatic herbicides was assessed by reviewing available toxicology data for each herbicide, calculating an acceptable dose for each formulation, and then determining a maximum acceptable concentration (MAC) in the water based on expected human ingestion rates of water or aquatic organisms. The MAC was then compared to the estimated environmental concentration (EEC). If the EEC is less than the MAC, no increased risk to human health is expected to occur (appendix B).

(ii) Routes of Exposure. Significant routes by which the general population can be exposed to aquatic herbicides are:

- using the lake or any affected ground water as a drinking water source (ingestion);
- swimming (ingestion and dermal exposure); and
- eating aquatic organisms (ingestion).

(iii) Maximum Acceptable Concentration. The acceptable dose (dose at which no adverse effects are expected to occur) for each herbicide formulation was calculated based on available toxicology data and on EPA regulations. This concentration, determined for each route of exposure, would be expected to cause no adverse effects to human health. The calculation of an acceptable dose assumes that the herbicide is not carcinogenic. Both endothall and fluridone have been determined by EPA not to cause cancer.

(iv) Potential Breakdown Product from Fluridone. N-methylformamide (NMF) is a potential photolytic breakdown product of fluridone. It is a potential teratogen, fetotoxin, hepatotoxin, and cytotoxin. NMF was first observed in laboratory photolytic studies (Saunders and Mosier 1983). However, NMF was not observed in field studies conducted outdoors in artificial ponds with radiolabelled fluridone (Berard and Rainey 1981) or in experimental ponds in Florida at a detection limit of 2 ppb (Osborne et al. 1989). Although NMF has never been observed as a breakdown product under natural conditions, its potential presence remains a concern. Therefore, worst case calculations were performed on its potential to affect human health (Appendix B-4). The safety factors for NMF exposure through drinking water and through skin absorption are very high. Under worst case conditions, a person would need to drink 15,852 gallons of treated drinking water per day to exceed the no-effects level. For incidental ingestion, a person would have to swim in fluridone treated water for 1,014 years under worst case conditions. Use of fluridone according to label instructions does not pose any effect to human health.

(v) Conclusions Concerning Human Health Risk. The risk to human health from using endothall and fluridone to control aquatic weeds can be described as follows:

- Based on the latest risk reference dose (RfD) issued by EPA (1988), initial concentrations of both endothall formulations exceed the water supply maximum acceptable concentrations (MACs) (worst-case scenario) for adults and children (2 L per adult per day, 1 L per child per day) during the first 35 days following application (appendix B-4).

- If we assume the longest half-life shown for endothall (8 days), ambient concentrations would not decline below critical levels for approximately 8 days for endothall-salt (Aquathol) and 12 days for endothall-amine (Hydrothol) for incidental ingestion (0.2 L per adult per day, 0.1 L per child per day). This exceedance is of concern since incidental ingestion is the most likely exposure route. Because of this, the State of Washington has suggested caution in the use of endothall. Management options to lessen risk are: (1) assume that swimming or contact with water is minimized for at least 10 days, and preferably twice that amount; (2) assume that endothall salts are not used in connection with any water directed for drinking; and (3) avoid use of amine formulation of endothall.

- No increased risk to human health is expected from consumption of fish living in waters treated with endothall.

- Swimming could lead to skin irritation after application of endothall,

although no information is available on concentrations causing irritation and available data did not allow a calculation of time required to reach non-irritant levels. Until these data are available, it should be assumed that skin irritation due to swimming after endothall applications could occur until endothall concentrations reach nondetectable levels. This is important to consider in the timing of treatment in swimming areas. Endothall product labeling indicates waters may be used for swimming 24 hours after application. A risk management suggestion is that 10-20 days be used as an exclusion period.

- No increased risk to human health is expected from incidental ingestion (0.2 L per adult per day, 0.1 L per child per day) by swimmers of water treated with fluridone, or from subsequent consumption of aquatic organisms from treated areas.

Concerns that have also been raised for the potential effects of NMF, a potential toxic breakdown product from fluridone appear to be without substantiation from further studies that have been conducted: NMF has never been found in a natural (non-laboratory) setting, and a worst-case analysis of human health effects (see Appendix B-5) suggests that, if the compound did occur in natural settings, an unreasonably large exposure would have to occur before it would cause a significant risk to human health.

(7) Community Cohesion. Controversy exists over use of herbicides for watermilfoil control. Some citizens want immediate chemical treatment because they feel it is the least expensive and most effective treatment available, while others are opposed to any chemical treatment because of environmental and public health considerations.

Similar controversy exists over use of mechanical harvesters. Some residents want immediate mechanical harvesting (sometimes as a preferred option to chemical treatment), while others are opposed to this method due to perceived increases of fragments in the water and on the beaches.

Finally, some citizens feel that public funds should not be spent to assist local programs for management of aquatic plants.

e. Relationship of Plan to Existing Plans, Policies, and Controls.

(1) Section 302, Public Law 89-298, as amended; Sections 103(c)(b) and 941, 1986 WRDA (Public Law 99-662). Starting on 1 October, 1987, Federal regulations and policies require the APMP to receive 50 percent cost-share in funding from the local sponsors. This represents a change from former levels of 30 percent local funding and 70 percent Federal funding. Local government participation is voluntary; if they do not believe the program would benefit their area, they are not required to participate.

(2) Clean Water Act of 1977 (Public Law 95-217).

(a) Section 404(b) Guidelines. These guidelines specify the procedures and policies for evaluating effects of discharge of dredged or fill material into waters of the United States and adjacent wetlands. It has been

determined by the Corps' Seattle District Regulatory Branch that none of the action alternatives require a 404(b) permit. Accordingly, a Section 404(b)(1) evaluation is not required.

(b) Section 401 Water Quality Certification. Under the Clean Water Act and Corps' regulations for its implementation, the local sponsor must apply to the Washington Department of Ecology for Section 401 water quality certification for the project. Mechanical harvesting, rotovation, and herbicides, but not bottom barriers, require such a water quality certification. Many of thee APMP control alternatives will require a short-term modification (permit) to the Water Quality Standards.

(3) Section 10, Rivers and Harbors Act of 1899. Under Section 10, the construction of any structure in or over any navigable water of the U.S., or the excavation from or deposition of material in such waters, is unlawful unless authorized by the Corps. A Section 10 permit would be required for the use of bottom barriers.

(4) Executive Order 11990, Protection of Wetlands. Executive Order 11990 directs Federal agencies to take actions which minimize destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. Activities for control of watermilfoil would be limited to submerged plants, but could include species other than watermilfoil. However, there remains a potential for water borne "drift" of weed fragments or of persistent herbicides such as Sonar into border wetland areas. Recommendations for proper uses of treatment options to avert such problems occur throughout this EISS, and will be considered by the State and local sponsors in their approved work plans. Accordingly, adverse impacts to wetlands and wetland uses would not occur (Section 4.03, Biological Impacts).

(5) Coastal Zone Management Acts.

(a) U.S. Coastal Zone Management Act of 1972. Under this act, a project that requires federal permits must be consistent with the State coastal zone management program. The Shoreline Management Act (SMA) of 1971 and the local Shoreline Master Programs (SMP) comprise Washington State's program. While it is the responsibility of the local sponsor to obtain required Substantial Shoreline Use Permits, the local sponsor is often the agent who issues these permits.

(b) Washington State Shoreline Management Act of 1971 (RCW 90.58). The Shoreline Management Act of 1971 provides "for the management of Washington's Shorelines by planning and fostering all reasonable and appropriate uses" (RCW 58.020). Under WAC 173-14, permits issued by local shoreline jurisdictions are required for substantial development, conditional uses, or variances on shorelines of the State that restrict the normal use of surface water by the public. Such permits must be obtained by the local sponsor from local shoreline jurisdictions.

(6) Hydraulic Project Approvals (R.C.W. 75.20.100, W.A.C. 220-110). Mechanical harvesting, rotovation, suction dredging, and bottom barriers but not herbicides or handpulling require hydraulic project approvals. Such permits must be obtained by the local sponsor from Washington Department of Fisheries or Washington Department of Wildlife.

f. Adverse Environmental Effects Which Cannot Be Avoided With Implementation of Alternative 1.

(1) Rotovation.

(a) Short Term. Minor adverse impacts to air quality would result from exhaust emissions from rotovators, and local noise levels would be increased during rotovation.

The major adverse impact caused by rotovation would be disruption of the substrate. Increased turbidity caused by rotovation would return to existing levels within hours. The benthic community would be displaced, destroyed, or exposed to predation; however, reestablishment of the benthic community should be rapid. Some nutrients absorbed on sediment would be reintroduced to the water column where they could become available to aquatic plants and algae, possibly resulting in localized algal blooms.

Suspended particulates from disrupted substrate may build up on beaches in soft bottom areas but the likelihood of this occurrence is minimal.

(b) Long Term. Rotovation is nonselective; almost every aquatic plant would be removed from the treatment area. Aquatic plants which would be removed provide habitat for a variety of aquatic organisms. Reestablishment of aquatic plant communities usually occurs within the next annual cycle; specific timing of reestablishment depends on the season and site of each treatment.

(2) Chemical Control.

(a) Short Term. watermilfoil treated with an aquatic herbicide would begin to die in a short time. Dissolved oxygen has the potential to be removed from the water by biological decomposition of dead plant biomass, depending on the size and type of water body. Decreased dissolved oxygen, especially in warm, shallow water, could result in fish mortality. "Nontarget" species may be killed or damaged by the herbicide since fluridone and endothall are nonselective.

Nutrients bound by watermilfoil would be released into water during decomposition. Increased nutrient levels could cause an algal bloom or an increase in growth of other aquatic plants.

Public recreation activities involving the treated areas would be temporarily restricted. (See Section 4.02d(6)).

(b) Long Term. Aquatic herbicides will remain in the water and sediments for varying periods of time depending on the chemical used and on physical characteristics of the treated water body.

Aquatic plants provide habitat for a variety of aquatic organisms and shelter for small fish. This habitat would be lost due to chemical treatment. Habitat loss would be greatest with fluridone because endothall is a contact herbicide which kills exposed parts of aquatic plants, allowing rapid regrowth.

In terms of risk management, guidelines in 4.02a(2)(b) and 4.02d(6) are

recommended for application to prevent loss of habitat by minimizing fluridone drift into riparian areas, and to minimize human health exposure and risk for the dipotassium or disodium salts of endothall.

Any chemical alternative has the potential to cause damage to wetland or upland plant species if treated water were used for irrigation inadvertently or not in accordance with label instructions.

(3) Data Gaps. Sometimes information is unavailable or unknown about a course of treatment. Such gaps for the chemical treatments considered in this EISS follow:

- Endothall has been inconclusively suggested to be an irritant to juvenile fish at near-normal application rates. However, the possible significance of the sublethal effects are unknown.

- There appear to be data gaps for the chronic toxicity for endothall which lead to assumptions concerning chronic toxicity risk to the aquatic environment and to humans. Additionally, some of the chronic tests used in the ecological risk assessment did not investigate reproductive success, one of the more sensitive indices, which could lead to an analysis which potentially underestimates the no observed effect concentration (NOEC) and chronic toxicity (appendices A-1, A-2).

4.03 Continuation of the 1979 EIS. Continuation of the 1979 EIS would involve no further actions except those already underway as part of the APMP. Choices of management under this alternative include mechanical harvesting, handpulling, rotovation, and bottom barriers. The initial program recommended that only limited areas be treated with endothall and did not consider the use of fluridone (Sonar). 2,4-D was the chemical of choice in the 1979 EIS. Continuation of 2,4-D is not a viable option under this alternative at this time, and has been suspended from the program de facto. Diquat and dichlobenil were also included in the original EIS but not encouraged for control treatment. In accordance with statements in section 2, however, 2,4-D, dichlobenil, and diquat would not be used; the use of 2,4-D awaits a determination by EPA regarding its human health effects. Impacts of these various methods of watermilfoil control on vegetation and habitat, wildlife and fish, threatened and endangered species, and habitats of concern are described in the 1979 EIS.

In summary, continuation of the initial APMP would have none of the physical, biological, cultural, or socioeconomic impacts described in section 4.02 for fluridone.

4.04 No-Action Plan. The no-action plan is the termination of Federal assistance in the control of watermilfoil. If a management program is not selected for an area infested with watermilfoil, the principal environmental impact would include expansion and growth of watermilfoil, resulting in changes to available habitat space and exclusion of native plants.

Consequences of accepting the no-action alternative follow:

• Risks of damage to the environment and human safety due to watermilfoil infestations are unacceptable in certain areas such as swimming beaches. Thus, the no-action alternative does not serve public needs.

• Recreation, fish and wildlife, and hydropower costs could be impacted by increased standing stocks of watermilfoil.

• Watermilfoil could spread into the Cowlitz River via overgrowth in Swofford Pond, and upstream in the Pend Oreille River past Albeni Falls Dam into Lake Pend Oreille, Idaho. Since Albeni Falls Dam is a Federal project, 100% Federal funding might be required for a large control and prevention project in Lake Pend Oreille, which has large areas of shallow water that are optimal for watermilfoil growth.

• Federal input on State treatment programs which influence operations of Federal dams (including Hiram Chittenden Locks, Chief Joseph, and Lower Columbia Dams) would diminish.

• No further Federal money would be available to local sponsors.

• Research at the University of Washington on herbivorous grass carp would not be completed.

• Involvement of Waterways Experiment Station (WES) would be decreased.

• A major cooperative program between the State of Washington and the Corps would be stopped.

• Less governmental control of treatments to avert overgrowth of watermilfoil could occur. METRO staff have indicated there may be "midnight treatments" which are illegal, but that the frequency this occurs is unknown.

In summary, termination of the 1979 EIS and non-implementation of the EISS selected alternative would have none of the impacts described in the 1979 EIS or described in section 4.02 of the EISS, but could have several potentially significant effects on economics of the Pend Oreille area and would not be responsive to a recognized public need.

SECTION 5. STUDY COORDINATION AND PUBLIC INVOLVEMENT; RESPONSES TO COMMENTS

5.01 Study Coordination and Public Involvement. The draft EIS for the APMP for the State of Washington was published in the Federal Register on 27 July 1979 and distributed for a 45-day review. Notice of availability of the final EIS was published in the Federal Register on 9 May 1980 and was subsequently distributed to the public for a 30-day review. A Record of Decision was prepared for the final EIS and was signed on 16 June 1980. A notice of intent to prepare a supplement to the EIS was published in the Federal Register on 20 May 1987 and a scoping letter for preparation of the EISS was distributed to agencies, tribes, organizations, and interested individuals on 31 March 1987.
Comments received on scoping letters (See Section 5 of draft EISS) were incorporated in the draft EISS. The draft EISS was circulated for public review in October 1989.

Comments on the draft EISS were received from:

FEDERAL AGENCIES

Environmental Protection Agency
U.S. Public Health Service, Department of Health and Human Services, Center for Disease Control
U.S. Department of the Interior, Fish and Wildlife Service

STATE GOVERNMENT

Washington Department of Ecology

LOCAL GOVERNMENTS

King - City of Bellevue
Municipality of Metropolitan Seattle (METRO)

PRIVATE INDIVIDUALS AND COMPANIES

Lakes Improvement Association, Gene Asseltine
Don-Elanco, Mark Binroker

5.02 Responses to Comments Received on Draft EISS. The letters are published in the following pages, followed by responses.

EPA

NOV . 9 1989

Reply To
Attn Of: WD-136

Vic Yoshino
U.S. Army Corps of Engineers
Seattle District
Attn: Environmental Resources Section
P.O. Box C-3755
Seattle, Washington 98124-2255

Dear Mr. Yoshino:

The Environmental Protection Agency (EPA) has reviewed the Draft Environmental Impact Statement (EIS) Supplement for the State of Washington Aquatic Plant Management Program. Our review was conducted in accordance with the National Environmental Policy Act and our responsibilities under Section 309 of the Clean Air Act.

This draft EIS supplements the final EIS for the Aquatic Plant Management Program prepared in October 1979. The EIS supplement reviews and updates geographic extent and treatment related components of the original program. The major changes in the proposed action include:

- Addition of new treatment areas on the Pend Oreille River and Swofford Pond on the Cowlitz River and deletion of the Okanogan-Columbia Rivers near Malott, Washington.

- Increased emphasis on the effectiveness of rotovation and additional data on the effects of bottom screens on water quality and invertebrates.

- Elimination of 2, 4-D and diquat for chemical treatment and inclusion of fluridone (Sonar) in the program. 1

On the basis of our review, we are rating the draft EIS supplement LO (Lack of Objections). An explanation of the EPA rating system for draft EISs is enclosed for your reference. This rating and a summary of our comments will be published in the Federal Register. 2

We appreciate the opportunity to review this EIS. If you have any questions about EPA's review please contact Sally Brough in our Environmental Review Section at 442-4012.

Sincerely,

Ronald A. Lee

Ronald A. Lee, Chief
Environmental Evaluation Branch

Enclosure

SUMMARY OF THE EPA RATING SYSTEM
FOR DRAFT ENVIRONMENTAL IMPACT STATEMENTS:
DEFINITIONS AND FOLLOW-UP ACTION *

Environmental Impact of the Action

LO--Lack of Objections

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC--Environmental Concerns

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA intends to work with the lead agency to reduce these impacts.

EO--Environmental Objections

The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU--Environmentally Unsatisfactory

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1--Adequate

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2--Insufficient Information

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3--Inadequate

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment

February, 1987

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333

October 19, 1989

Col. Philip L. Hall
District Engineer
Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124-2255

Dear Col. Hall:

We have reviewed the Draft Environmental Impact Statement Supplement (DEISS) for the State of Washington Aquatic Plant Management Program. We are responding on behalf of the U.S. Public Health Service. Technical assistance for this review was provided by the Environmental Impact Section, Center for Food Safety and Applied Nutrition, Food and Drug Administration.

The Supplement states that use of registered herbicides will be consistent with, and subject to, appropriate EPA regulations, and that 2,4-D will not be used pending EPA reconsideration of health information. Only the EPA-registered herbicides endothall and fluridone will be considered as options for chemical control methods. We were pleased to see a summary of a risk assessment including a consideration of potential human exposures to these herbicides via ingestion of water and fish and via dermal exposure in the appendices.

The following specific comments are provided for consideration before issuance of a final document:

1. The changes in the management program listed as Alternative 2 seem to have already been implemented: a new herbicide, fluridone, has been in use in 1988 and 1989; the Pend Oreille River was added to the aquatic management program in 1982, and the Okanogan-Columbia Rivers area was apparently dropped from the program in 1983. Table 2-2, which contrasts the three alternatives, suggests that the only real program change is the broader use of fluridone. As stated in the CEQ regulations, agencies should not take actions that would have adverse environmental impacts or limit the choice of alternatives before the agency makes its decision (40 CFR 1506.1). It appears that the actions which comprise the "Preferred Alternative" have already been undertaken. Consequently, the role of this DEISS in agency decision making needs to be clarified in the Final document. 1

2. The discussion of the alternatives and their effects does not address how the management program decides which method should be used. If, in fact, the decision to be made is the extent to which fluridone use be broadened, then the DEISS should consider how control methods are selected. Some quantitative information about the existing program (area of milfoil treated, number of projects using different methods) would be helpful in making a comparison of the alternatives. 2

In discussing effects of herbicide treatment, a statement is made on page 4-2 that "Problems with dissolved oxygen are not expected because treatment is limited to small areas which provide adequate water exchange from untreated areas". Again, we were unable to locate any statements of the criteria for determining when or where specific control procedures should be used.

3. There are some unsupported consequences described in the discussion of the "no action" alternative. For example, "risks of damage to the environment and human safety due to milfoil" are alleged (p. 4-15), but prior discussions mentioned only aesthetics, tourism and recreation as being affected by milfoil. Also, the specter of "uncontrolled local (possibly illegal) treatments" is mentioned as another consequence of the no-action alternative, however, why such treatments would be more likely without Corps involvements is not discussed. 3

4. The DEISS fails to explain why the Okanogan-Columbia Rivers area is being dropped from the program. If there is some decision to be made, its reasons should be explained in the document. 4

5. Issues of compliance with existing requirements are not resolved. Table i-1 notes that the recommended project attains only "partial" compliance with certain environmental requirements (pp.vii-ix). However, the document's discussion of compliance (pp. 4-12 to 4-13) fails to discuss the specific items noted as "partial" compliance in Table i-1. A statement of "partial" compliance with requirements should be explained in the text. 5

6. The half-life of fluridone (page 2-7) appears to be quite variable ("5 to 20 days", page B-12). Is there an explanation for this, for example, is there any correlation with water parameters? In light of the stated affinity for sediment and moderate persistence, are there any test results on effects to organisms in sediment? 6

7. In Table 2-3, N-methylformanide is mentioned but appears not to be discussed in the text. Are there any effects data, bioconcentration, or other fate data available? 7

8. Drift effects are mentioned, then mitigated by suggesting that fluridone would be packaged in fibers. Apparently this was an experimental technique; is it going to be implemented into the proposed control program? 8

Thank you for the opportunity to review this DEISS. Please insure that we are included on your mailing list for future Draft Environmental Impact Statements.

Sincerely yours,

Kenneth W. Holt

Kenneth W. Holt, M.S.E.H.
Environmental Health Scientist
Center for Environmental Health
and Injury Control

cc:
Dr. Buzz Hoffmann
Dr. Michael Harrass

United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW
1002 N.E. HOLLADAY STREET, SUITE 354
PORTLAND, OREGON 97232-4181

TAKE PRIDE IN AMERICA

November 2, 1989

ER 89/792

Colonel Milton Hunter
District Engineer
Seattle District
U.S. Army Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Colonel Hunter:

The Department of the Interior has reviewed the Draft Environmental Impact Statement Supplement for Aquatic Plant Management Program, State of Washington. The following comments are provided for your consideration when preparing the final document.

The U.S. Fish and Wildlife Service's (Service) order of preferred treatments under the proposed action are: (1) mechanical harvesting, (2) Rotovation, (3) Fluridone (Sonar), and (4) Intergrated Control. The Service prefers Fluridone for control by chemical means because it generally has a very low toxicity to nontarget organisms, results in minimal depression of oxygen, and is relatively effective in slow, stagnant waters. The Service recommends focusing on intergrated control, pending favorable results of the ongoing investigations with herbivorous fish. 1

Thank you for the opportunity to comment.

Sincerely,

Charles S. Polityka

Charles S. Polityka
Regional Environmental Officer

ABU

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

November 20, 1989

Environmental Resources Section
U.S. Army Corps of Engineers
Seattle District
P.O. Box C-3755
Seattle, WA 98124-2255

Dear Sirs:

Thank you for the opportunity to comment on the draft environmental impact statement for the State of Washington Aquatic Plant Management Program.

The State of Washington is also in the process of preparing a supplemental environmental impact statement on the Aquatic Plant Management Program in Washington. We anticipate our preferred alternative will be the use of an integrated management approach, with an emphasis on identifying and utilizing alternatives to aquatic herbicides as much as possible. We support the Corps' proposal to use a similar approach.

1. Table 2-2, Status of Control Methods. This table should reflect current status and what is not effective. Specifically, fragment barriers are not really effective. 1

2. Table 2-3. Mechanical control methods were not compared in fragile or sensitive ecosystems through navigation. We understand this information is available, but was not printed in the table. 2

3. Page 4-13. The paragraph on the Shoreline Management Act should be expanded to explain that control methods which restrict the normal use of surface waters by the public may require a shoreline substantial development permit. The local government agency should be contacted regarding shoreline permits. 3

4. Page 2-9. Additional information on the plant pathogen fungus is currently available from researching the literature. This information should be included in the EIS. 4

5. Elanco Company has merged with Dow Chemical Company and they have a new name. You may want to include this in the final EIS. 5

6. Section 2.02, Alternative 1.d, Bottom Barriers, should read: "Bottom barriers in 1979 were composed of polyvinyl chloride-coated fiberglass screen which limited sunlight ...." The last sentence "Two other types ...." should be deleted. 6

7. Page 4-10. The organization should be changed to the following: 7

- (6) Public Health
  - (a) General
  - (b) Rotovation
  - (c) Herbicides
    1. Human health risk assessment
    2. Routes of exposure
    3. Maximum acceptable concentration
    4. Conclusions concerning human health risk

8. Appendix E, Worst Case Calculations for NMF, should be edited for clarification. 8

9. The Aquatic Plant Management Program does not appear to include a public information and education. We would suggest this be added, particularly some discussion of the relationship between excessive macrophyte growth and accelerated or cultural eutrophication due to nutrient enrichment, and the need for these problems to be addressed through basin or lake management planning. 9

10. In Section 4.03.e, mention should be made of the requirement for obtaining a short-term modification (permit) to the Water Quality Standards (Chapter 173-201 WAC) for most, if not all, of the control alternatives since these activities (particularly the introduction of toxic substances) is contrary to Chapter 173-201 WAC and the Federal Water Quality Act of 1989. 10

11. Section 4.03.f. The Department of Wildlife and the Department of Ecology's Wetland Section have recently raised the issue of wetland and habitat mitigation in association with unavoidable impacts. Ecology will likely be addressing this issue in our supplemental EIS, and would encourage the Corps to do likewise. 11

12. The EIS should also acknowledge that the proposed alternatives are generally short-term cures aimed at controlling the symptoms, i.e., excessive macrophyte growth, resulting from the overlying problem of accelerated or cultural eutrophication. 12

If you have any questions, please call Ms. Joan Hardy of the Water Quality Program at (206) 438-7001, or Mr. Bruce Smith or Ms. Nora Jewett of the Shorelands Program at (206) 459-6762.

Sincerely,

Barbara J. Ritchie

Barbara J. Ritchie
Environmental Review Section

BJR:

cc: Linda Rankin, Shorelands
Bruce Smith, Shorelands
Bob Nichols, AQ-44
Joan Hardy, Water Quality
Steve Saunders, Water Quality

City of Bellevue

Design and Development Department 455-6864 FAX 637-5225
Post Office Box 90012 • Bellevue, Washington • 98009 9012

October 23, 1989

Mr. Vic Yoshino
Environmental Resources Section
U.S. Army Corps of Engineers - Seattle District
PO Box C-3755
Seattle, WA 98124-2255

Re: Comments on Draft Environmental Impact Statement Supplement for the State of Washington Aquatic Plant Management Program.

Dear Mr. Yoshino:

Thank you for the opportunity to review the above referenced document. Given the City of Bellevue's location on the shores of both Lake Washington and Lake Sammamish, we are very interested in changes to this management program, which is in effect in both of these lakes.

In general, we are pleased to see what appears to be a shift in the Corps general management philosophy away from chemical treatment toward mechanical treatment methods. Nonetheless, we remain concerned about the impacts associated with the chemical treatment methods still promoted in the program.

Our specific comments on the EIS are as follows:

- On pages 4-3 through 4-7, the conclusion is reached that both Endothall and Fluridone are subject to chemical and/or biological breakdown and do not persist indefinitely in water, sediments, or aquatic organisms. Assuming that the substances themselves do not persist in aquatic organisms, but given the impacts to those organisms that ingest these herbicides (minimal at recommended concentrations), what are the associated impacts to offspring of those organisms affected? 1

  We understand from the data gap noted on page 4-14 that not enough is know about the reproductive success of aquatic species after exposure to endothall. Given this lack of data, is there data on any direct impact to whatever offspring are created? Is there any information on either the reproductive success or affect on offspring of aquatic organisms exposed to non-lethal doses of fluridone? Are future generations in any way more susceptible to problems caused by ingestion of these same chemicals? Could these offspring be affected by lower concentrations of the same chemicals as a result of the ancestral exposure? 2

- Assuming that much of the information discussed above regarding bio-accumulation and impacts to offspring is not available in existing data, what risk assumptions are made in the document for the long range cumulative impacts associated with the chemical treatment methods discussed?

- In the discussion of chemical and biological breakdown on page 4-2, it is stated that "no detectable residues of N-methylformamide (NMF), the most toxic residue of fluridone, have been found in any water samples collected through 168 days after Sonar treatment". The discussions of the impacts of fluridone to vegetation/habitat types and wildlife/fish, however, do not discuss the impacts of NMF at all. These discussions are limited to the direct impacts of fluridone. Given that NMF is "the most toxic residue of fluridone" (and may be more toxic than fluridone itself) and given that detectable levels are found in water samples up to 168 days after Sonar treatment, the document should include a discussion of the impacts of NMF, similar in detail to the discussions of the impacts of endothall and fluridone. 3

If you have any questions or concerns about these comments, please feel free to give Ray Sachs a call at 455-6864.

Sincerely,

Janet Garrow
Acting Environmental Coordinator

JG:RS

METRO
Municipality of Metropolitan Seattle
Exchange Building • 821 Second Ave. • Seattle, WA 98104-1598

October 23, 1989

Mr. Vic Yoshino
Seattle District
U.S. Army Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124-2255

Dear Mr. Yoshino:

Metro appreciates the opportunity to respond to the DEISS for the Aquatic Plant Management Program. You have assembled a good deal of useful information on aquatic control methods.

Our response is based on the Uniform Herbicide Policy which has been reaffirmed by the Metro Council every two years since 1980. The policy recommends against diquat, dichlobenil and 2,4-D. It encourages non-chemical control methods, but states that endothall and fluridone (the latter recently added) are acceptable when other methods have been determined to be infeasible. This policy was based on studies of various control methods, a risk assessment and literature review of chemicals, and public and interagency review. 1

Metro does not use herbicides in its control program; rather harvesting and bottom screening are the chief control methods. In addition, Metro plans to conduct rotovation in Lake Washington in 1990, considering it to be a promising new method.

While we consider the DEISS proposed alternative to be the preferred one, we believe that the language related to chemical use needs some clarification and should be stronger. For instance, under the proposed alternative, diquat and dichlobenil are "not encouraged." It is not clear whether this is more or less permissive than the language "recommended only for limited use" in alternative 1. Metro opposes the use of both these chemicals and would suggest language such as "not recommended" or "recommended against" or, at least, the more restrictive of the two alternatives. 2

Endothall is proposed to be "recommended" or "ok" for limited use. This is relatively similar to Metro's policy, but we would propose language that adds "when mechanical or physical control methods are determined to be infeasible." Our risk assessment indicates data gaps for chronic toxicity, and the information on page 4-11 of the DEISS are among the reasons for caution in the use of endothall. 3

Fluridone is considered "ok for use" in the DEISS. We consider fluridone in the same category as endothall. Data gaps about sediment toxicity and experience of the Department of Ecology at Swofford Pond, where habitat seemed to be impaired, indicate reason for caution. 4

We consider rotovation a promising new method which should be included. We would concur that other new methods, such as biological controls are in the experimental stage and are not ready for programmatic use. 5

A few specific comments on the DEISS follow:

1. Page 2-7: The persistence of fluridone in sediments should be included. 6

2. Table 2-2: Suction Dredge. Alternate 1: "..cannot be treated with herbicides" should read "herbicide treatment is infeasible or not desired." 7

3. Table 2-2: Fragment Barriers, Alternative 2: This should be consistent with text statement that they were ineffective. 8

4. Table 2-3: Endothall effectiveness: A Metro study indicated "growback potential within 30 days". 9

5. Table 2-3: The word "none" for the human toxicity of integrated control should be deleted. 10

Again, thank you for the opportunity to comment. If you have any questions, please call me at 684-1230.

Yours truly,

Judy Bevington

Judy Bevington
Water Quality Planner
Water Resources Section

JB:ln(deiss)

L I A

Lakes Improvement Association

P.O. Box 3344
Lacey, WA 98503

October 18, 1989

Mr. Vic Yoshino
Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA., 98124 - 2255

Re: Draft Environmental Imapct Staterent Supplisent for
the Aquatic Plant Management Program

Dear Mr. Yoshino;

The DEISS is well-written and informative. The Board of Directors of the Lakes Improvement Assoxiation took formal action to support the following comments.

Our comments are directed to Section 1: The Aquatic Plane Management Program (pages 1-1 and 1-2). We strongly commend the Corps for its milfoil eradication effort at Swafford Pond. In the face of "conventional wisdom" that milfoild eradication was impossible, the Corps and rhw Dep't of Ecology were willing to try a new approach.

With the limited funds available, we would support additional similar efforts. Specifically, we propose a priority system for ranking proposed future projects :

1. Educational efforts to reduce the spread of non-native aquatic plants by humans. 1
2. Research programs and pilot/demonstration projects to advance the "state of the art" in non-native weed control and eradication (including but not limited to milfoil)
3. Surveillance for and spot treatment of pioneer infestations of non-native aquatic weeds.

We feel the eligibility for Corps PL 89-298 funds should be expanded in the Seattle District to include and project meeting one or more of the above objectives. 2 We believe that would advance yhe knowledge and achieve better containment of noxious weeds than the currdnt arbitrary criterion of limiting funding to navigable waters.

We would be glad to work with you and the Department of Ecology to develope a more detailed processfor selecting projects to maximize the benefit derived from the limited funds.

Thank you for the opportunity to comment on the DEISS.

Sincerely,

Gene Isselstine, President

cc:Kathy Hamil, Dept. of Ecology

Hicks Lake, Pattison Lake, Long Lake

October 23, 1989

Mr. Vic Yoshino
Department of the Army
Seattle District Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124-2255

Dear Mr. Yoshino:

On October 16, 1989, I received your National Environment Policy Act Draft Environmental Impact Statement Supplement for the Aquatic Plant Management Program.

Thank-you for including SONAR* (Fluridone) in your analysis. I have reviewed this document and have only a few inputs for changes I would request you make in reference to SONAR.

1) Under Table 2-2 -- Status of Control Methods Regarding Fluridone, Alternative 2, change to:

"Ok to Use. Selective herbicide. Controls Milfoil."

SONAR is a selective herbicide which provides long term control of milfoil, hydrilla, and other undesirable aquatic weeds. Because it is selective, SONAR can be managed in a way to provide little to no harm of desirable native species or allow re-establishment as habitat for aquatic life. See the attached list of species that SONAR provide control , partial control or no control. This list along with other label changes have been submitted to EPA. We should receive full approvals shortly. 1

2) In Table 2-3, under Human Toxicity, and Fluridone, please change paragraph 4 to read:

"N-methylformamide (NMF) is a breakdown product of fluridone under laboratory conditions. But recent field studies have shown that, NMF has never been detected following treatment under actual field use conditions." 2

3) In Table 2-3, under Cost and Fluridone, the $650 - $800/AC figure is much too high. For 1-2 lbs. AI/ACRE of SONAR the actual cost of material would be approximately $240 - $480 per acre treated. When SONAR is properly applied, we are experiencing two (2) year control of Eurasian Water Milfoil, which reduces the cost per acre per year to $120 - $240/AC. In a contained system, such as an entire lake or pond, SONAR also controls targeted species in an expanded area up to three (3) times the area treated -- three (3) acres of control for 3

* SONAR (Fluridone - Elanco Products Company)

each acre treated. When this is factored in, SONAR* cost per acre per year for milfoil control would be $40 - $80/AC/YR.

4) Section 4-14 - Paragraph 4, referencing: "This habitat would be lost due to chemical treatment. Habitat loss would be greatest with fluridone..." We feel this statement is not accurate when referencing SONAR, and should be modified or removed.

Several years of research and large scale commercial usage has proven SONAR can provide selective control of problem species including Hydrilla and Eurasian water milfoil with little to no harm to many native species. Our position is that Habitat should be improved from the use of fluridone, not as the draft statement indicates. See my earlier comments for additional support.

Thank-you again for including SONAR in your Impact Statement. We look forward to you being able to make these modifications, and hopefully using SONAR in the problem areas of the Pacific Northwest.

If you have any further questions, please contact:

Dr. Steve Cockreham 250/1
Lilly Research Laboratories
P.O. Box 708
Greenfield, IN 46140-0708
Phone: (317)467-4151

Also, please add Dr. Cockreham and myself to your list to receive the final version.

Best Regard,

Mark Buroker

Elanco Products Company
Mark Buroker
Sonar Marketing

cc: Dr. Steve Cockreham

MB/alt

:attachment

SONAR LABEL
SPECIES CONTROLLED
Pending E.P.A. Approval - Submitted 9/89

Controlled Species

Floating:

*Common Duckweed (Lemna) — AS formulation only, not controlled with pellets.

Emersed:

*Spatterdock (Nuphar) — Controlled with AS and 5P. Only partial control with both 5p and SRP.

*Waterlilly (Nymphaea) — Controlled with AS. Partial Control with 5P/SRP

Paragrass

Submersed:

*Bladderwort (Utricularia)
*Common Coontail (Ceratophyllum)
*Common Elodea (Canadensis)
Brazilian Elodea (Egeria)
Hydrilla
*Naiad (Najas)
*Pondweed (Potamogeton) Except Illinois Pondweed
*Watermilfoil (Myriophyllum)
Fanwort (Cabomba)

Partial Control:

Alligatorweed
*American Lotus (Nelumbo)
*Cattail
*Common Water-meal (Wolffia)**
*Common Waterprimrose (Ludwiga)
Giant cutgrass (Zizaniopsis)
*Illinois Pondweed
Parrot's-feather (Myriophyllum)
Reed Canarygrass
*Smartweed (Polygonum)
*Spikerush (Eleocharis)

* Northern Species
**Partial control only with a surface application of Sonar AS at full rate

Southern watergrass (Hydrochloa)
Topedograss (Panicum)
Waterpurslane (Ludwiga)
*Watershield (Bransenia)

<u>Not Controlled:</u>

*Algae
American frog's-bit
*Arrowhead
Bacopa
Banana Lilly (Nypmhoides)
*Bulrush (Scirpus)
Floating Water-Hyacinth
Maidencane (Panicum)
*Pickerweed (Pontederia)
Rushes
*Tapegrass (Vallisneria)
Water lettuce (Pistia)
Water pennywort (Hydrocotyle)

Note: Best control will be achieved when treating a contained system such as an entire lake or pond.

Diminishing control of marginal species may occur when treating 50% or less of the water body.

* [illegible] Species

a. US Government Agencies.

1. **Environmental Protection Agency.**

Comment No. 1. Diquat has not been eliminated from the program, but instead is "not recommended." See Table 2-2, page 2-14 in this final EISS. Recent information developed by the State of Washington in its SEPA EISS indicates that diquat can still have a role in aquatic plant control.

Comment No. 2. Comment acknowledged.

2. **US Public Health Service, Department of Health and Human Services, Centers for Disease Control.**

Comment No. 1. The final EISS reflects that the actions to which you refer have already been taken and documented under NEPA by annual environmental assessments. Corps of Engineers regulations for implementing NEPA do not require public circulation of environmental assessments in every case. The purpose for the supplement is to provide results of NEPA analysis in a public document which considers their individual and cumulative effect on the program and on the degree of environmental protection that is afforded by program elements. This is the NEPA process of tiering. The net result is not to limit reasoned choice of alternatives, but to document and provide an updated and consistent program that may be used by the cost sharing sponsors and the State of Washington. Finally, some of the changes to which you refer such as the use of fluridone were pilot-level, not full program implementation events.

Comment No. 2. The management program works in the following manner. Local advocates of treatment programs deal with the State of Washington Aquatic Plant Program. The State determines which of the programs have merit for cost-sharing, using the guidelines provided by the Corps in the EIS (and now the EISS) plus its own State Environmental Policy Act documentation for herbicides. It is possible, for example, that endothall use may be "OK" under the Corps' environmental documentation, but discouraged by the State (or METRO) for actual use. The Corps does not indicate the method to be used nor its breadth of application, and is primarily involved in providing Federal cost-share and environmental documentation of possible methods. The statement regarding fluridone being limited to "small areas which provide adequate water exchange from untreated areas" refers to general guidance used by the State in applying this chemical. Such general constraints which are imposed by the state on a case-by-case basis are not generally specified in the EISS because conditions can be conceived where a larger water body might be treated with appropriate monitoring and consideration of environmental effects. The text just prior to Table 1-1 has been modified to clarify these points.

As to quantitative information on use of different methods, the State of Washington annually produces an application report that describes the extent of use of all treatments that are available. This historical information does not directly assist the comparison of alternatives for the sake of providing a framework for management options, however.

Comment No. 3. There are documented drownings from entanglement in watermilfoil and also documented illegal treatments of Washington water bodies using Casoron, 2,4-D, and other terrestrial chemicals. The Corps' involvement in the management plan is to provide a Federal cost-share mechanism because it has been determined that there is a Federal interest in preventing the spread and minimizing the growth of this weed in the State of Washington. To the extent that it provides a public process involving reasoned selection of environmentally-compatible treatment or management options, the program prevents illegal or ignorant use of inappropriate herbicides. There will also be illegal treatments of this nature with the action alternative (and the text has been modified to indicate this).

Comment No. 4. The primary reason for these rivers' original inclusion in the program is historic: at the time of the EIS, they were the advancing front of watermilfoil spread toward the Columbia River. Now, the weed is in the Columbia River for most of its length, and it is no longer appropriate to treat the tributary rivers. The EISS indicated that stopping spread of the weed has not been the most successful program element. Again, the decisions are made by the State based on need. The EISS is simply registering the current state of affairs.

Comment No. 5. "Partial" compliance means that some requirements will be completed by the completion of the EISS or by approval of individual actions by acquisition of permits or approvals from local shoreline jurisdictions or other permitting entities. The text has been expanded to clarify this.

Comment No. 6. It is correct that there is a substantial variation in the half-life of fluridone, and it is a persistent chemical. Further information has been added to the EISS regarding its persistence and effective life. In general, in experimental ponds under field conditions, a minimum of 8 weeks and a mean of 17 weeks' persistence at detectible levels has been observed; and in laboratory settings, one year. In contrast, aqueous half-lives of fluridone have been observed from 4 to 7 days. Fluridone's persistence in hydrosoils is a matter for consideration in selection of methodology. The persistence of the chemical means that impacts to vegetation may occur for up to a year after treatment. However, note that for animal life, fluridone has a low toxicity.

Comment No. 7. NMF is discussed in the text and in Appendix B-5. NMF was first observed in laboratory photolytic studies, and is of concern because it is a potential teratogen, fetotoxin, hepatotoxin, and cytotoxin. NMF has never been observed as a breakdown product under natural conditions. Dow-Elanco performed worst-case calculations to estimate its potential to affect human health, and concluded that the safety factors for NMF exposure through drinking water and skin absorption are very high. Under worst case conditions, one would need to drink 15,852 gallons of treated drinking water per day to attain the NOEL, or greater than 78,0777 gallons per day under realistic case conditions. For incidental ingestion, one would have to swim in fluridone treated water for 1,014 years under worst case conditions, or more than 5,070 years under realistic case conditions in order to exceed the NOEL exposure. Accordingly, use of fluridone according to label instructions does not pose any effect to human health. In response to this comment, additional text has been added to the document to make this conclusion more easily accessible.

Comment No. 8. The use of fibers to treat with fluridone has been carried out

experimentally for several years in the Pend Oreille River. At present, this formulation is not generally available, but is expected to be in future. Such formulation is approved for use in the APMP.

3. Department of the Interior, Fish and Wildlife Service

Comment No. 1. Comment acknowledged.

b. State of Washington

1. Department of Ecology.

Comment No. 1. This change has been made in the EISS.

Comment No. 2. A page was omitted from the draft EISS. A change page was sent out during the comment period, and the final EISS has this page.

Comment No. 3. This change has been made in the EISS.

Comment No. 4. The referenced information does not substantially change any of the conclusions that pathogens are still in the development stage, which was stated in the draft EISS.

Comment No. 5. This change has been made in the EISS.

Comment No. 6. This change has been made in the EISS.

Comment No. 7. This change has been made in the EISS.

Comment No. 8. Comment noted.

Comment No. 9. We agree that lake and basin management planning is desirable. Information on the public education aspect of the APMP has been added to the final EISS. Comprehensive basin planning is beyond the scope of the APMP, although actions taken under the auspices of the APMP may contribute to lake and watershed plans. We note that the spread of watermilfoil in the Columbia River and elsewhere is not driven by cultural eutrophication alone. Excessive watermilfoil growth in water bodies is partially due to the virtually unchecked growth which opportunistically occupies water and sediment that would otherwise be available for more beneficial plants or for animal use. The growth habit of watermilfoil is what makes it noxious. Eutrophication may encourages its growth, but watermilfoil also grows in nearly oligotrophic situations, and has the ability to slow the rate of flowing water which increases sedimentation and modifies the sediments to encourage the weeds' greater growth.

Comment No. 10. This change has been made in the EISS.

Comment No. 11. The Corps does not intend to encourage use of treatments in the program to damage or modify habitat. In most cases where control methods are approved, existing aquatic habitat has already been adversely affected by the presence of watermilfoil, and the treatment should improve matters. Mitigation in

the sense of avoidance of impacts is encouraged by the language of the EISS: for example, information has been added regarding possible drift effects of fluridone that will alert potential sponsors to possible effects on marginal wetlands. The State and Corps reviews of proposed work plans should identify when and where such problems could occur. If adverse impacts to wetlands are predicted or occur, mitigation (that is, compensation or replacement of habitat values) is required under Federal and State laws, guidelines and interagency agreements.

Comment No. 12. See comment 9.

c. Local Governments

1. City of Bellevue.

Comment No. 1. Further information on this topic has been added to the EIS. In summary, uptake of fluridone is quite low for aquatic organisms: rainbow trout had a bioconcentration factor of 91 and a chironomid insect, 128. Fluridone has been reported not to accumulate in fish above the concentration in water, and subsequent residues in tissue were found to be very low. Mosquito fish survived and produced viable young at a wide range of fluridone concentrations. Fathead minnows were observed not to be affected by a lifetime exposure to 0.48 mg/L or less. Similar results are reported for daphnids, amphipods, and midge larvae at 0.2-0.6 mg/L exposure levels. At the recommended label rate of application of 1 pound per acre in a 3-foot-deep pond, an effective concentration of 0.1 mg/L would occur. Accordingly, fluridone is not expected to have acute or chronic adverse effects on animal species. Appendix A of the FEISS further discusses the aquatic environmental risk assessment conclusions regarding fluridone. None of the criterion values were exceeded, suggesting that at a minimum, 95% of species are protected.

Comment No. 2. While endothall has a very low potential to bioaccumulate in organisms such as fish, there is an acknowledged data gap regarding reproductive effects. There is, at present, no technical basis for adverse multigeneration effects from endothall such as suggested in the comment. From what is known of other compounds that do not bioaccumulate significantly and are not fat soluble, it is unlikely that offspring would be affected while parents would not show either adverse acute or chronic effects. Accordingly, the risk assessment did not consider multigeneration effects. However, the data gap could suggest caution in use of this chemical. The final EISS has been modified to reflect such caution.

Comment No. 3. The draft EISS contained information on NMF, and the final EISS has been edited to more clearly lead readers to this information. See also response to comment number 7 by the Centers for Disease Control, above. The final EISS concludes that NMF, even under worst-case conditions, would not lead to significant adverse public health effects.

2. Municipality of Metropolitan Seattle (METRO).

Comment No. 1. METRO's policy is consistent with the guidance in the EISS and the intent of the management plan to provide environmentally-compatible alternatives (which may not be selected at the sponsor's option).

Comment No. 2. The comment asks for more restrictive language regarding diquat and dichlobenil. The State of Washington is currently reviewing these compounds in its SEPA EISS, and it appears at present that endothall may be more cautiously applied than previously, while diquat may be more environmentally acceptable than previously thought. "Not encouraged" and "recommended only for limited use" are functionally similar language. METRO and Ecology may not approve an alternative treatment based on their knowledge of its effects, in accordance with the intent of the management program. The text has been changed slightly in the cited table to reflect the known data gaps and cautionary notes.

Comment No. 3. Fluridone and endothall are very different chemicals in terms of their biological action, bioaccumulation potential, persistence, and toxicity to nontarget aquatic life. METRO's comment that they are in the same category is acknowledged, but is not in line with differences and impacts which are described in the text.

Comment No. 4. We fundamentally agree that mechanical alternatives are preferable to chemical ones if everything else is equal. The selection of the alternative is up to the sponsor and State to decide, however. The referenced data gap is acknowledged, and may lead Ecology or METRO to discourage or limit endothall use on a case-by-case basis.

Comment No. 5. Additional text has been added to the final EISS regarding persistence of fluridone in sediment and potential for persistence of its vegetation-limiting capability for a year or possibly more in cool climates. In Swofford Pond, two years following initial application of fluridone in the pilot project, white stems were observed on rootstocks of watermilfoil as well as other aquatic macrophytes. This suggests that the toxicity is persisting longer than expected. The information will likely be used to refine management decisions regarding the scope of areas to be treated with fluridone.

Comment No. 6. Comment acknowledged.

Comment No. 7. The change has been made in the EIS.

Comment No. 8. The change has been made in the EIS.

Comment No. 9. The change has been made in the EIS.

Comment No. 10. The change has been made in the EIS.

Comment No. 11. The change has been made in the EIS.

c. Private Individuals and Companies.

1. **Lakes Improvement Association, Gene Asselstine.**

Comment No. 1. Comment acknowledged.

Comment No. 2. All of these activities are currently part of the program for the State of Washington or are ongoing research in macrophyte control conducted

from the Corps' Waterways Experiment Station (WES) in Vicksburg, MS. Several projects from WES are occurring in the State of Washington.

Comment No. 3. Comment noted.

2. Dow-Elanco, Mark Buroker.

Comment No. 1. Selectivity is a somewhat relative term. As used in the EISS, it means ability to target watermilfoil. The list you have provided includes a number of other genera and species that occur in our region and are considered benign. The text of the table has not been changed, although experience at Swofford Pond has been added.

Comment No. 2. The text has been changed as suggested.

Comment No. 3. The text has been modified.

Comment No. 4. The persistence of fluridone effects at Swofford Pond (see response to comment 5 from METRO) suggests that vegetation may be affected for considerable periods. While we agree that presence of eurasian watermilfoil in this region is usually associated with degraded habitat, it is not possible to regard the subsequent area which lacks macrophytes as improved habitat in the short term. Possibly, once regrowth of native vegetation occurs, the habitat will be restored. In the aquatic plants program, it is intended that possible habitat effects will be considered in approving case-by-case use of fluridone.

SECTION 6. REFERENCES

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APPENDIX A

AQUATIC ECOLOGICAL RISK ASSESSMENT

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AQUATIC ECOLOGICAL RISK ASSESSMENT

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AQUATIC ECOLOGICAL RISK ASSESSMENT

I. INTRODUCTION

A. Background

Impacts on the aquatic environment may occur from the use of herbicides which kill or inhibit the growth or reproduction of certain species of aquatic plants. Additionally, herbicides used for watermilfoil control possess the potential to adversely affect "non-target" species of aquatic life, including fish and invertebrates. This appendix is a summary of aquatic ecological risk procedures and assessments used by METRO (1986) for the herbicides endothall and fluridone. Ecological risk assessment is used to provide data for management decisions despite data gaps which require assumptions to be made.

In order to quantify ecological risks of adverse effects, estimates are made of concentrations of the herbicides that can be used while protecting most resident aquatic life. These estimates are called criteria concentrations. Criteria concentrations are compared to estimated environmental concentrations (EEC) expected to occur in the water after application of herbicides at the recommended rates. Ecological risk assessment is accomplished by determining if the EEC is lower than the criterion concentration for aquatic toxicity.

B. Methods Used for Risk Assessment

A METRO study (1986) employed two assessment methodologies to seek estimates of herbicide concentrations that can be used while protecting most aquatic life from both acute (brief and severe) and chronic (long-term and low level) toxicity:

(1) OPP (EPA Office of Pesticide Program's aquatic ecological risk assessment methodology) (EPA 1986c), and

(2) OCS (EPA Office of Criteria and Standard's water quality criteria approach) (EPA 1985d).

The OPP aquatic ecological risk assessment methodology is used before an herbicide is registered for use and seeks to protect most important species. The OCS water quality criteria approach is used for compliance monitoring in receiving waters after the herbicides are widely used, is more rigorous than EPA's OPP approach because it requires a larger and more ecologically representative data base and generates criteria for more uses of aquatic life, and attempts to protect 95 percent of aquatic species, endangered species, and those that are economically important.

II. RISK ASSESSMENT RESULTS

A. EPA OPP Aquatic Ecological Risk Assessment

1. Procedure

The aquatic ecological risk assessment procedure of EPA's OPP compares:

- EEC (estimated environmental concentrations) to measures of acute toxicity (such as the median lethal concentration or LC_{50}; in this case the lowest LC_{50} determined from the required tests (EPA 1984) is multiplied by 0.10, a safety factor that is supposed to protect all the species without test data), and

- EEC to measures of chronic toxicity (such as the no observed effect concentration (NOEC) from chronic tests).

OPP distinguishes three risk levels for acute toxicity:

(1) no risk,

(2) risk that can be mitigated by restricted use, and

(3) unacceptable risk of impacting aquatic life;

and only two risk levels for chronic toxicity:

(1) no risk, and

(2) unacceptable risk.

The METRO report (1986) states that assessments based on the OPP approach overestimate the risk from acute toxicity and may underestimate the risk from chronic toxicity. In this case, data bases for acute toxicity were much larger than those required by EPA and were probably representative of the herbicides' acute toxicity to aquatic life. However, there were data gaps for chronic toxicity for endothall which lead to assumptions concerning chronic toxicity risk. Additionally, some of the chronic tests failed to investigate reproductive success, one of the more sensitive indices, which would underestimate the no observed effect concentration (NOEC) and hence underestimate chronic toxicity.

2. Assessment

For ecological risk assessment, the first step compares laboratory toxicological data with the EEC (estimated environmental concentration). For acute toxicity evaluation, OPP multiplies the lowest LC_{50} from tests of its standard species (here the lowest EC_{50} or LC_{50} reported from the data set was used) by a safety factor of 0.10 to protect sensitive species that have not been tested. This value was compared to a time averaged EEC for a 4-day period, the time most species are exposed in acute toxicity tests.

EEC's for amine formulation of endothall (Hydrothol) exceeded the acute toxicity criterion value (table 1). The EEC's do not exceed the acute criteria concentrations for fluridone and endothall salts, although the EEC for fluridone is just below the criterion value.

A good chronic toxicity data base was available for fluridone, but important data for the amine formulations of endothall were lacking (appendixes A and B). Due to this deficiency, it was assumed that the acute chronic ratio of 5.2, obtained from the chronic test of endothall salts, could be applied to the acute toxicity data in order to estimate the NOEC. This is a traditionally acceptable means of estimating NOECs, if the assumption of the mechanism of toxic action at the cellular level is the same for each formulation of endothall, despite apparent differences in uptake rates and metabolism (e.g., Hermans et al., 1985; Lipnick 1985; and McCarty et al., 1985).

The EEC's for several weeks following herbicide application were compared with the criterion concentrations for chronic toxicity, and none of the formulations exceeded the criterion (table 2).

B. EPA's OCS National Water Quality Criteria

1. Procedure

The second aquatic ecological risk assessment technique, based on EPA's Office of Criteria and Standards procedure for deriving national water quality criteria, specifies concentrations that cannot be exceeded in natural waters without potentially adversely impacting more than 5 percent of the species of aquatic life. The risk assessment procedure followed but did not adhere strictly to the EPA procedure for several reasons:

- Not all of the fluridone data were reviewed as carefully as EPA recommends for meeting data quality requirements;

- Endothall data provided by the manufacturer, Pennwalt Corporation, were not accompanied by detailed reports of the test results;

- Test results on endothall from the U.S. Fish and Wildlife Service, National Environmental Research Center, Columbia, Missouri, were accepted by the METRO contractor although only the general test conditions were described; and

- For some formulations there were data gaps, notably chronic toxicity data.

Consequently, the criteria developed should be considered estimates (appendix A-3).

Five criteria values were developed by application of the National water quality criteria guidelines:

- Final Acute Value (FAV), designed to ensure protection of 95 percent of the species of fish and invertebrates from acute toxicity, defined by an LC_{50};

- Final Residue Value, designed to ensure protection of both the public health and wildlife that prey on aquatic life from biomagnification of residues through the food web;

- Final Chronic Value, designed to ensure protection of fish and invertebrates from chronic toxicity;

- Criterion Maximum Concentration, one-half the final acute value (FAV); and

- Criterion Continuous Concentration, an estimate of the threshold for an unacceptable effect from long-term, chronic exposure; equal to the lowest concentration obtained for either the Final Residue Value or the Final Chronic Value.

After determining which data were suitable for calculating the criteria, a Final Acute Value was calculated to ensure protection of 95 percent of the species from acute toxicity using the lowest four mean acute values (Erickson and Stephan, 1985). Each Mean Acute Value was calculated by averaging the acute toxicity values according to the taxonomic groupings of the organisms (by genera). The fit of all data on a plot of Mean Acute Values against probabilities was examined to add insight as to whether the lowest four points were representative of the data set.

Acute chronic ratios were obtained by dividing the acute toxicity value by the corresponding chronic toxicity value, and the final acute chronic ratio is the geometric mean of all the ratios. A Final Chronic Value was obtained by dividing the Final Acute Value by the geometric mean of the final acute chronic ratio.

2. Assessment

The risk assessment performed using EPA's water quality criteria approach compares the estimated EEC's to criteria calculated for different types of exposure which are derived under stringent guidelines for acceptable data quality, the types of tests that must be run, and the types and number of species that must be tested (Stephan et al., 1985). The data base for fluridone came closest to fulfilling the requirements of the guidelines.

None of the criteria values are exceeded for endothall salts or fluridone (table 3). Therefore, it should be possible to use these herbicides without significant risk to 95 percent or more of the aquatic animal species; however, up to 5 percent of the aquatic species could be impacted adversely.

The amine formulation of endothall (Hydrothol) appears to pose a significant threat of acute toxicity to more than 30 percent of the animal species, due to the 4-day EEC exceeding all criterion maximum

concentrations considered. Because it has rapid decay which reduces EEC's so quickly, Hydrothol did not exceed the criterion for chronic toxicity.

C. Comparison of Assessments

The results of the water quality based risk assessment compare favorably with those made by EPA OPP's ecological risk assessment aproach. Although the two approaches differ substantially in terms of data requirements, the rigor of the calculations, and the aquatic life uses explicity protected, the approaches are conceptually similar. Both approaches indicated that the amine formulation of endothall could adversely affect a higher percentage of the aquatic species than is normally tolerated.

The question of sediment toxicity to aquatic life is of concern only with herbicides that possess three properties in the following order of importance: high affinity for particulate matter, slow rate of degradation (i.e., persistence), and significant toxicity. The herbicides rank as follows with respect to these properties:

Herbicide	Affinity for Particulates	Slow Degradation	Toxicity
Fluridone	High	Yes	Moderate
Endothall	Low	No	Moderate

Fluridone could thus accumulate and persist in the sediments. The prediction of sediment toxicity to aquatic life is complex, primarily because only a fraction of the fluridone occurring in the sediments will be available to bottom dwelling organisms in a form they can assimilate. Some species will only be able to take up dissolved fluridone via their skin and gills, while others may ingest sediments. The exposure concentrations will decline progressively after herbicide application due to leaching of sediment-bound fluridone into the water column and degradation of fluridone. It was suggested by the contractor that trial applications in the field be conducted in order to confirm that sediment toxicity does not occur, given the characteristics of herbicide application, water quality, and aquatic animals considered.

Another problem concerning risk assessment posed to aquatic life stems from use of granular formulations of the herbicides; there are significant uncertainties about estimates of exposure concentrations and hazard to bottom dwelling organisms. Little information was available concerning the rapidity at which the herbicides leached from the granules. Granular formulations are designed to concentrate the herbicide at the bottom, in close proximity to the roots of aquatic plants. Calculations for EEC's were based on the assumption that the herbicide would completely mix in the entire water column upon release from the granular formation. Mixing will not likely occur this rapidly. Data on leaching rates, as well as more sophisticated models to predict ECCs, are needed in order to separately predict EEC's for bottom and water column dwelling organisms. At that time, risk assessments could be accomplished easily by comparing the more

accurate EEC's for granular formulations to the appropriate criterion concentrations already calculated in this report.

III. SUMMARY AND CONCLUSIONS

The risk to aquatic life from the use of endothall and fluridone was assessed using two methodologies developed by EPA: the Office of Pesticide Programs' aquatic ecological risk assessment methodology and the Office of Criteria and Standards' water quality criteria approach. The OPP approach is used in the registration of herbicides, and the OCS approach is used in deriving water quality criteria for chemicals. Both assessments indicated that use of amine formulations of endothall has the potential for significantly impacting aqatic life. This determination was based on comparison of herbicide concentrations causing acute and chronic toxicity with those estimated to occur in the water after application. Estimated environmental concentrations for endothall salts as well as fluridone were below those known to be acutely and chronically toxic to most organisms. However, all organisms are not protected; herbicide concentrations identified here as not causing significant adverse impacts may still adversely impact 5 percent of the aquatic species. Economically important and endangered/threatened species are expected to be protected at the forecast herbicide application rates and estimated exposure concentrations.

The risk assessments may have underestimated impacts to bottom-dwelling species from use of granular formulations because they are designed to initally create the highest herbicide concentrations on the bottom near the plant roots. The estimates assumed complete instantaneous mixing of all granular formulations. With additional information, the degree of risk to aquatic life imposed by use of granular formulations can be determined.

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TABLE 1

COMPARISON OF ACUTE TOXICITY CRITERIA TO THE ESTIMATED ENVIRONMENTAL CONCENTRATIONS (EEC's) BASED ON EPA'S OPP RISK ASSESSMENT PROCEDURE

Compound	Lowest LC_{50} (ppm)	Criterion Concentration $1/10*LC_{50}$ (ppm)	4-Day Geometric Mean EEC (ppm)1/	Exceedance
Fluridone	1.3	0.13	0.126	No
Endothall Salts	23.	2.3	1.00	No
Endothall (Hydrothol)	0.18	0.018	1.43	Yes

1/Geometric mean concentration averaged over the first 4 days following application, calculated using the initial concentrations and most representative half-lives.

TABLE 2

COMPARISON OF CHRONIC TOXICITY CRITERIA TO THE ESTIMATED ENVIRONMENTAL CONCENTRATIONS (EEC's) BASED ON THE EPA'S OPP RISK ASSESSMENT PROCEDURE

Compound	Criterion Concentration Lowest NOEC (ppm)	Chronic EEC (ppm)	Exceedance
Fluridone	0.20	0.08 1/ 2/	No
Endothall Salts	5.00	0.06 3/	No
Endothall (Hydrothol)	0.07	0.02 3/	No

1/Geometric mean concentration for the first 21 days following application, calculated using the initial concentrations and most representative half-lives.

2/Duration is equivalent to the duration of the test of the most sensitive species subject to chronic toxicity testing.

3/Geometric mean concentratfon for the first 28 days following application, calculated using the initial concentrations and most representative half-lives.

TABLE 3

RISK ASSESSMENT RESULTS CONCERNING ACUTE TOXICITY, CHRONIC TOXICITY AND BIOMAGNIFICATION OF HERBICIDES IN FRESHWATER USING EPA'S OCS WATER QUALITY CRITERIA APPROACH

Criterion	EEC (ppm)	Criterion Concentration (ppm) 95% of Species	Exceedance of 95% Criterion
Endothall Salts (Dipotassium and Disodium)			
Final Acute Value	1.00	16.5	No
Acute-Chronic Ratio	N/A	5.2	N/A
Final Residue Value	1.00	None	Not Expected
Final Chronic Value	0.06	3.2	No
Criterion Max. Conc.	1.00	8.3	No
Criterion Continuous Conc.	0.06	3.2	No
Endothall Amine (Hydrothol)			
Final Acute Value	1.43	0.32	No
Acute-Chronic Ratio 1/	N/A	5.2	N/A
Final Residue Value	1.43	None	Not Expected
Final Chronic Value	0.02	0.06	No
Criterion Max. Conc.	1.43	0.16	Yes
Criterion Continuous	0.02	0.06	No
Fluridone			
Final Acute Value	0.13	0.70	No
Acute-Chronic Ratio	N/A		6.9 N/A
Final Residue Value	0.13	350.0	No
Final Chronic Value	0.08	0.10	No
Criterion Max. Conc.	0.13	0.35	No
Criterion Continuous Conc.	0.08	0.10	No

1/No acute-chronic ratio was available, therefore the ratio for the disodium and dipotassium salts of endothall was used.

APPENDIX A-1

TOXICITY TABLES FOR 2,4-D, ENDOTHALL, AND FLURIDONE

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TABLE A-1

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF 2,4-D TO AQUATIC LIFE

Species	Formulation	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted 1/	Reference
2,4-D ACID AND SALTS										
Fathead Minnow *Pimephales promelas*	DMA 2/	335 3/	96 hr	Static	FW 4/	Mortality (LC50)	Subadults	Nominal	Yes	Schultz (1973)
American Eel *Anguilla rostrata*	Acid	300.6	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)
Smallmouth bass *Micropterus dolomieui*	DMA	236 3/	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Channel Catfish *Ictalurus punctatus*	DMA	193 3/	96 hr	Static	FW	Mortality (LC50)	Subadults	Nominal	Yes	Schultz (1973)
Bluegill *Lepomis macrochirus*	DMA	177 3/	96 hr	Static	FW	Mortality (LC50)	Subadults	Nominal	Yes	Schultz (1973)
Bluegill *Lepomis macrochirus*	DMA	168 3/	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Channel Catfish *Ictalurus punctatus*	DMA	155 3/	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Rainbow Trout *Salmo gairdneri*	DMA	100 3/	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Chinook Salmon *Oncorhynchus tshawytscha*	DMA	100 3/	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Amphipod *Gammarus fasciatus*	DMA	100 3/	96 hr	Static	FW	Immobilization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Carp *Cyprinus carpio*	Acid	96.5	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)
Pumpkin Seed *Lepomis gibbosus*	Acid	94.6	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)
Guppy *Poecilia reticulata*	Acid	70.7	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)

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TABLE A-1

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF 2,4-D TO AQUATIC LIFE

Species	Formulation	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted1/	Reference
2,4-D ACID AND SALTS (Continued)										
Striped Bass *Morone saxatilis*	Acid	70.1	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)
Cutthroat Trout *Salmo clarki*	Acid	64	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Lake Trout *Salvelinus namaycush*	Acid	45	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
White Perch *Morone americana*	Acid	40.0	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)
Banded killifish *Fundulus diaphanus*	Acid	26.7	96 hr	Static	FW	Mortality (LC50)	N.G. 5/	Nominal	Yes	Rehwoldt et al. (1977)
Carp *Cyprinus carpio*	Acid	20.0	96 hr	Static Renewal	FW	Mortality (LC50)	Adult	Nominal	Yes	Vardia and Durve (1981)
Bleak *Alburnus alburnus*	NaSalt	12.9	48 hr	Static	FW	Mortality (LC50)	Embryo	Nominal	No 6/	Biro (1979)
Daphnia lumholtzi	N.G. 7/	10.0	38 hr	Static	FW	Mortality (LC50)	Adult	Nominal	No 8/	George et al. (1982)
Ostracod *Cypridopsis*	DMA3/	8.0	48 hr	Static	FW	Immobilization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Rasbora Neilgherriensis	Acid	5.6	96 hr	Static	FW	Mortality (LC50)	Adult	Nominal	No 6/	Vardia and Durve (1981)
Rotifer *Brachionus calyciflorus*	N.G. 7/	5.0	24 hr	Static	FW	Mortality (LC50)	Adult	Nominal	No 9/	George et al. (1982)
Daphnia magna	DMA3/	4.0	48 hr	Static	FW	Immobilization	Naiad	Nominal	Yes	Johnson and Finley (1980)

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TABLE A-1 (Continued)

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF 2,4-D TO AQUATIC LIFE

Species	Formulation	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1]	Reference
2,4-D ACID AND SALTS (Continued)										
Labeo boga	Acid	3.8	96 hr	Static	FW	Mortality (LC50)	Adult	Nominal	No [6]	Vardia and Durve (1981)
Prawn Palaemonetes	DMA[3]	0.15	48 hr	Static	FW	Immobil-ization	Juvenile	Nominal	No[10]	Johnson and Finley (1980)
BUTOXYETHYL ESTER (BEE), BUTYL ESTER (BE), AND PROPYLENE GLYCOL BUTYL ETHER ESTER OF (PGBEE)2,4-D										
Daphnia magna	BEE	6.4	48 hr	Static	FW	Immobil-ization	First instar	Nominal	Yes	Johnson and Finley (1980)
Amphipod Gammarus fasciatus	BEE	6.1	48 hr	Static	FW	Immobil-ization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Fathead Minnow Pimephales promelas	BEE	5.6	96 hr	Static	FW	Mortality (LC50)	Adult	Nominal	Yes	Mount and Stephan (1967)
Cladoceran Simocephalus	PGBEE	4.9	48 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Fathead minnow Pimephales promelas	BEE	3.3	96 hr	Static	FW	Immobil-ization	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Amphipod Gammarus fasciatus	PGBEE	2.9	48 hr	Static	FW	Immobil-ization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Isopod Asellus	BEE	2.6	48 hr	Static	FW	Immobil-ization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Stonefly Pteronarcella	PGBEE	2.4	96 hr	Static	FW	Immobil-ization	First year	Nominal	Yes	Johnson and Finley (1980)
Ostracod Cypridopsis	BEE	2.2	48 hr	Static	FW	Immobil-ization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Stonefly Pteronarcys californica	BEE	1.6	96 hr	Static	FW	Mortality (LC50)	Nymphs	Nominal	Yes	Sanders and Cope (1968)

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TABLE A-1 (Continued)

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF 2,4-D TO AQUATIC LIFE

Species	Formulation	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1/]	Reference
BUTOXYETHYL ESTER (BEE), BUTYL ESTER (BE), AND PROPYLENE GLYCOL BUTYL ETHER ESTER OF (PGBEE)2,4-D (Continued)										
Stonefly *Pteronarcella*	BE	1.5	96 hr	Static	FW	Mortality (LC50)	Naiad	Nominal	Yes	Johnson and Finley (1980)
Cutthroat Trout *Salmo clarki*	PGBEE	1.2	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Woodward and Mayer (1978)
Daphnia magna	PGBEE	1.2	48 hr	Static	FW	Immobilization	First instar	Nominal	Yes	Johnson and Finley (1980)
Bluegill *Lepomis macrochirus*	BEE	1.2	96 hr	Static	FW	Immobilization	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Lake Trout *Salvelinus namaycush*	PGBEE	1.1	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Lake Trout *Salvelinus namaycush*	PGBEE	1.1	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Woodward and Mayer (1978)
Rainbow Trout *Salmo gairdneri*	PGBEE	1.0	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Cutthroat Trout *Salmo clarki*	PGBEE	1.0	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Cutthroat Trout *Salmo clarki*	BE	0.9	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Lake Trout *Salvelinus namaycush*	BE	0.9	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Lake Trout *Salvelinus namaycush*	BE	0.84	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Woodward and Mayer (1978)
Cutthroat Trout *Salmo clarki*	BE	0.74	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Woodward and Mayer (1978)
Bluegill *Lepomis macrochirus*	PGBEE	0.6	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)

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TABLE A-1 (Continued)

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF
2,4-D TO AQUATIC LIFE

Species	Formulation	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted1/	Reference
BUTOXYETHYL ESTER (BEE), BUTYL ESTER (BE), AND PROPYLENE GLYCOL BUTYL ETHER ESTER OF (PGBEE) 4-D (Continued)										
Rainbow Trout *Salmo gairdneri*	BEE	0.518	96 hr	Flow-through	FW	Mortality (LC50)	Juvenile	3 time	Yes	Finlayson and Verrue (1985
Ostracod *Cypridopsis*	PGBEE	0.4	48 hr	Static	FW	Immobil-ization	Naiad	Nominal	Yes	Johnson and Finley (1980)
Prawn *Palaemonetes*	PGBEE	0.4	96 hr	Static	FW	Immobil-ization	Juvenile	Nominal	Yes	Johnson and Finley (1980)
Pink Salmon *Oncorhynchus gorbuscha*	BEE	0.45	96 hr	Static	FW	Mortality (LC50)	Fry	Nominal	Yes	Martens et al. (1980)
Coho Salmon *Oncorhynchus kisutch*	BEE	0.45	96 hr	Static Renewal	FW	Mortality (LC50)	Fry	Nominal	Yes	Martens et al. (1980)
Sockeye Salmon *Oncorhynchus nerka*	BEE	0.45	96 hr	Static Renewal	FW	Mortality (LC50)	Fry	Nominal	Yes	Martens et al. (1980)
Amphipod *Gammarus lacustris*	BEE	0.44	96 hr	Static	FW	Mortality (LC50)	Adult	Nominal	Yes	Sanders (1969)
Chinook Salmon *Oncorhynchus tshawytscha*	BEE	0.315	96 hr	Flow-through	FW	Mortality (LC50)	Juvenile	3 times	Yes	Finlayson and Verrue (1985)
Rainbow Trout *Salmo gairdneri*	BEE	0.3	96 hr	Static Renewal	FW	Mortality (LC50)	Fry	Nominal	Yes	Martens et al. (1980)

1/ Refers to whether there were data of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).
2/ DMA = Dimethylamine salt.
3/ The dimethylamine salt was not converted to the acid equivalent.
4/ FW = Freshwater.
5/ Life stage of organism not given (N.G.) in reference.
6/ Data were not used in criteria derivation because the species was not indigenous to North America.
7/ Formulation of 2,4-D was not specified in reference.
8/ Data were not used in criteria derivation because test formulation was not specified, and test was not of sufficient duration.
9/ Data were not used in criteria derivation because test formulation was not specified in reference.
10/ Data not used in criteria derivation because value was twenty times lower than the other toxicity values, the original test data will have to be examined to determine whether the test is valid.

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TABLE A-2

DATABASE USED FOR EVALUATING THE CHRONIC TOXICITY OF 2,4-D TO AQUATIC LIFE

Species	Formulation[1/]	Toxic Concentration, ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[2/]	Reference
Fathead minnow *Pimephales promelas*	BEE	0.3	10 months	Flow-through	FW[3/]	Development and Survival	Egg to Spawn	15 times	Yes	Mount and Stephan (1967)
Lake trout *Salvelinus namaycush*	BE	0.033	60 days	Flow-through	FW	Development and Survival	Egg to Fry	Biweekly	Yes	Woodward and Mayer (1978)
Chinook salmon *Oncorhynhus tshawytscha*	BEE	0.040	36 days	Flow-through	FW	Development and Survival	Egg to Fry	Weekly	Yes	Finlayson and Verrue (1985)
Lake trout *Salvelinus namaychush*	PBEE	0.052	60 days	Flow-through	FW	Development and Survival	Egg to Fry	Biweekly	Yes	Woodward and Mayer (1978)
Cutthroat trout *Salmo clarki*	PGBEE	0.031	60 days	Flow-through	FW	Development and Survival	Egg to Fry	Biweekly	Yes	Woodward and Mayer (1978)
Cutthroat trout *Salmo clarki*	BE	0.024	60 days	Flow-through	FW	Development and Survival	Egg to Fry	Biweekly	Yes	Woodward and Mayer (1978)

1/ BEE = butoxyethyl ester; BE = butyl ester; PGBEE = propylene glycol butyl ether ester.

2/ Refers to whether there were data of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).

3/ FW = Freshwater.

TABLE A-3

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF ENDOTHALL TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm [1] (mg/l)	Acid Equivalent ppm [2] (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Test Accepted[3]	Reference
Fathead Minnow <u>Pimephales promelas</u>	DiNaSalt	320	257	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Bluegill <u>Lepomis macrochirus</u>	DiNaSalt	280	225	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Folmar (1977)
Bluegill <u>Lepomis macrochirus</u>	DiNaSalt	280	225	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Folmar (1977)
Bluegill <u>Lepomis macrochirus</u>	Acid	220	220	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Largemouth bass <u>Micropterus salmoides</u>	DiNaSalt	200	160	96 hr	Static	FW[4]	Mortality (LC50)	Fingerling	Yes	Folmar (1977)
Rainbow Trout <u>Salmo gairdneri</u>	Aquathol K	528.7	151	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Black Bullhead <u>Ictalurus melas</u>	DiNaSalt	182.5	146	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Bluegill <u>Lepomis macrochirus</u>	Aquathol K	501.2	143	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Yellow Bullhead <u>Ictalurus natalis</u>	DiNaSalt	172.5	138	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Bluegill <u>Lepomis macrochirus</u>	DiNaSalt	125-150	110[7]	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Largemouth Bass <u>Lepomis macrochirus</u>	DiNaSalt	>135	>108	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)
Redear Sunfish <u>Lepomis microlophus</u>	DiNaSalt	125	100	96 hr	Static	FW	Mortality (LC50)	N.G.[5]	Yes	Pennwalt Corp. (1986)

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TABLE A-2 (Continued)

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF ENDOTHALL TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm [1] (mg/l)	Acid Equivalent ppm [2] (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Test Accepted [3]	Reference
Fathead Minnow <u>Pimephales promelas</u>	DiNaSalt [6]	120-125	98 [7]	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Largemouth Bass <u>Micropterus salmoides</u>	DiNaSalt	120-125	98 [7]	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Folmar (1977)
Bluntnose Minnow <u>Pimephales notatus</u>	DiNaSalt	110-120	92 [7]	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Amphipod <u>Gammarus lacustris</u>	Aquathol K [6]	>320	>92	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
<u>Daphnia magna</u>	Aquathol K	319.5	91	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Red Shiner <u>Notropis lutrensis</u>	DiNaSalt	105	84	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Redfin Shiner <u>Notropis umbratilis</u>	DiNaSalt	95	76	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Bluegill <u>Lepomis macrochirus</u>	Aquathol K	230	66	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Bluegill <u>Lepomis macrochirus</u>	DiNaSalt	75	60	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
<u>Daphnia magna</u>	Tech Acid [6]	32.5	32.5	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)
Chinook Salmon <u>Oncorhynchus tshawytscha</u>	Aquathol K	82	23	96 hr	Static	FW	Mortality (LC50)	N.G. [5]	Yes	Pennwalt Corp. (1986)

1/ Frequency of concentration measurements is nominal for all tests.
2/ Toxicities of various formulations of endothall were converted to the acid equivalent, using the following conversions: Aquathol K multiplied by 0.286, (based upon percent active ingredient and ratio of molecular weight of the acid to the molecular weight of the DiNa Salt) and DiNa Salt multiplied by 0.802 (based upon the ratio of the molecular weight of endothall acid to the DiNa Salt).
3/ Refers to whether these data are of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).
4/ FW = Freshwater.
5/ Life stage of organism not given (N.G.) in reference.
6/ DiNa Salt = disodium salt of endothall; Aquathol K = dipotassium salt of endothall; Tech Acid = technical acid.
7/ Geometric mean.

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TABLE A-4

DATABASE USED TO EVALUATE CHRONIC TOXICITY OF ENDOTHALL TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm 1/ (mg/l)	Acid Equivalent ppm 2/ (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Test Accepted 3/	Reference
Bluegill *Lepomis macrochirus*	DiNaSalt 2/	100	80	21 days	Static	FW 4/	No toxic effect (NTE)	N.G. 5/	6/	Folmar (1977)
Stoneroller *Campostoma anomalum*	DiNaSalt	50	40	N.G. 7/	N.G. 8/	FW	No observed effect level (NOEL)	Egg-Fry	6/	Pennwalt Corp. (1986)
Redfin Shiner *Notropis umbratilis*	DiNaSalt	40	32	21 days	Static	FW	No toxic effect (NTE)	N.G. 5/	6/	Folmar (1977)
Red Shiner *Notropis lutrensis*	DiNaSalt	40	32	21 days	Static	FW	No toxic effect (NTE)	N.G. 5/	6/	Folmar (1977)
Bluntnose Minnow *Pimephales notatus*	DiNaSalt	40	32	21 days	Static	FW	No toxic effect (NTE)	N.G. 5/	6/	Folmar (1977)
Green Sunfish *Lepomis cyanellus*	DiNaSalt	25	20	N.G. 7/	N.G. 8/	FW	No observed effect level (NOEL)	Egg-Fry	6/	Pennwalt Corp. (1986)
Rainbow Trout *Salmo gairdneri*	DiNaSalt	10	8	21 days	Static	FW	No toxic effect (NTE)	N.G. 5/	6/	Folmar (1977)
Largemouth Bass *Micropterus salmoides*	DiNaSalt	10	8	21 days	Static	FW	No toxic effect (NTE)	N.G. 5/	6/	Folmar (1977)
Rainbow Trout *Salmo gairdneri*	DiNaSalt	6.25	5	N.G. 7/	N.G. 8/	FW	No observed effect level (NOEL)	Egg-Fry	6/	Pennwalt Corp. (1986)

1/ Frequency of concentration measurements not provided in reference.
2/ The acid equivalent was calculated to normalize the data. The Disodium salt (DiNaSalt) value was multiplied by 0.802 to obtain the acid equivalent.
3/ Refers to whether these data are of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).
4/ FW = Freshwater.
5/ Life stage of organism not given (N.G.) in reference.
6/ The toxicity data were used to calculate an approximate acute-chronic ratio, although they were not assumed to be acceptable tests without detailed review of all the necessary test data.
7/ Exposure time of the organisms to test material was not provided in reference.
8/ Type of test, flow-through or static, was not given (N.G.) in reference.

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TABLE A-5

DATABASE USED TO EVALUATE THE ACUTE TOXICITY OF ENDOTHALL (HYDROTHOL 191) TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1]	Reference
Rainbow Trout *Salmo gairdneri*	Hydrothol 191	1.3	96 hr	Static	FW[2]	Mortality (LC50)	N.G.[3]	N.G.[4]	Yes	Pennwalt Corp. (1986)
Bluegill *Lepomis macrochirus*	Hydrothol 191	1.2	96 hr	Static	FW	Mortality (LC50)	N.G.[3]	N.G.[4]	Yes	Pennwalt Corp. (1986)
Bluegill *Lepomis macrochirus*	Hydrothol 191	0.94	96 hr	Static	FW	Mortality (LC50)	Fry	Nominal	Yes	Johnson and Finley (1980)
Fathead Minnow *Pimephales promelas*	Hydrothol 191	0.75	96 hr	Static	FW	Mortality (LC50)	Fry	Nominal	Yes	Johnson and Finley (1980)
Rainbow Trout *Salmo gairdneri*	Hydrothol 191	0.56	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)
Amphipod *Gammarus lacustris*	Hydrothol 191	0.50	96 hr	Static	FW	Mortality (LC50)	Mature	Nominal	Yes	Johnson and Finley (1980)
Channel Catfish *Ictalurus punctatus*	Hydrothol 191	0.49	96 hr	Static	FW	Mortality (LC50)	Fry	Nominal	Yes	Johnson and Finley (1980)
Amphipod *Gammarus lacustris*	Hydrothol 191	0.48	96 hr	Flow-through	FW	Mortality (LC50)	N.G.[3]	N.G.[4]	Yes	Folmar (1977)
Daphnia magna	Hydrothol 191	0.36	96 hr	Static	FW	Mortality (LC50)	N.G.[3]	N.G.[4]	Yes	Pennwalt Corp. (1986)
Cutthroat Trout *Salmo clarki*	Hydrothol 191	0.18	96 hr	Static	FW	Mortality (LC50)	Fingerling	Nominal	Yes	Johnson and Finley (1980)

1/ Refers to whether these data are of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).
2/ FW = Freshwater.
3/ Life stage of organism was not given (N.G.) in reference.
4/ Frequency of concentration measurements was not given (N.G.) in reference.

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TABLE A-6

DATABASE USED FOR EVALUATING THE ACUTE TOXICITY OF FLURIDONE TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1/]	Reference
Amphipod *Gammarus pseudolimnaeus*	Fluridone[2/]	>32	96 hr	Static	FW[3/]	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Amphipod *Gammarus pseudolimnaeus*	Fluridone[2/]	>32	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Fathead minnow *Pimephales promelas*	Fluridone	15.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	14.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	13.5	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	13.2	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	13.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Bluegill *Lepomis macrochirus*	Fluridone	13.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Bluegill *Lepomis macrochirus*	Fluridone	12.1	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Assayed	Yes	Hamelink et al. (1986)
Bluegill *Lepomis macrochirus*	Fluridone	12.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Assayed	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	11.7	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	10.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	10.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	10.0	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)

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TABLE A-6 (Continued)

DATABASE USED FOR EVALUATING THE ACUTE TOXICITY OF FLURIDONE TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1/]	Reference
Rainbow trout *Salmo gairdneri*	Fluridone	8.4	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	8.2	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	8.1	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Assayed	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	7.7	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	7.6	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	7.6	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	7.6	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	7.1	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Daphnia magna	Fluridone	6.3	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hemelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	5.7	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	5.6	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	4.5	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Daphnia magna	Fluridone	4.4	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hemelink et al. (1986)
Rainbow trout *Salmo gairdneri*	Fluridone	4.2	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)

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TABLE A-6 (Continued)

DATABASE USED FOR EVALUATING THE ACUTE TOXICITY OF FLURIDONE TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1/]	Reference
Amphipod *Gammarus pseudolimnaeus*	Fluridone	4.1	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Daphnia magna	Fluridone	3.9	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Daphnia magna	Fluridone	3.9	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Daphnia magna	Fluridone	3.6	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Amphipod *Gammarus pseudolimnaeus*	Fluridone	2.1	96 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Midge *Chironomus plumosus*	Fluridone	1.3	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1966)
Midge *Chironomus plumosus*	Fluridone	1.3	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Midge *Chironomus plumosus*	Fluridone	1.3	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)
Midge *Chironomus plumosus*	Fluridone	1.3	48 hr	Static	FW	Mortality (LC50)	N.G.[4/]	Nominal	Yes	Hamelink et al. (1986)

1/ Refers to whether there were data of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).

2/ Fluridone formulation used was a field formulation containing 48 percent active ingredient of fluridone. This is the only species in which the toxicity of the field formulation was significantly different than the technical grade, and hence mentioned here.

3/ FW = Freshwater.

4/ Life stage of the animal was not given (N.G.) in reference.

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TABLE A-7

DATABASE USED FOR EVALUATING THE CHRONIC TOXICITY OF FLURIDONE TO AQUATIC LIFE

Species	Compound	Toxic Concentration ppm (mg/l)	Exposure Time, Hours	Type of Test	Test Medium	Type of Response	Life Stage	Frequency of Concentration Measurements	Test Accepted[1/]	Reference
Amphipod *Gammarus pseudolimnaeus*	Fluridone	1.2	60 days	Flow-through	FW[2/]	Development and survival	Lifecycle	Weekly	Yes	Hamelink et al. (1986)
Midge *Chironomus plumosus*	Fluridone	1.2	30 days	Flow-through	FW	Emergence	Larvae to Adult	Weekly	Yes	Hamelink et al. (1986)
Channel catfish *Ictalurus punctatus*	Fluridone	1.0	60 days	Flow-through	FW	Development and survival	Fry to Adult	Weekly	Yes	Hamelink et al. (1986)
Fathead minnow *Pimephales promelas*	Fluridone	0.96	90 days	Flow-through	FW	Survival	Lifecycle	Weekly	Yes	Hamelink et al. (1986)
Daphnia magna	Fluridone	0.2	21 days	Flow-through	FW	Survival and Reproduction	Lifecycle	Weekly	Yes	Hamelink et al. (1986)

1/ Refers to whether there were data of sufficient quality to meet the requirements of the EPA guidelines for criteria derivation (Stephan et al. 1985).

2/ FW = Freshwater.

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APPENDIX A-2

SUMMARY OF TOXICITY DATA

APPENDIX A-2

SUMMARY OF TOXICITY DATA

Available toxicity data are summarized along with the results of data analyses. Available toxicity data indicate that the endothall salts (e.g., disodium and dipotassium endothall), which readily dissociate to the endothall cation, are much less toxic than the amine of endothall (Hydrothol 191). Acute toxicities of the salts to freshwater species ranged from 23 ppm to 257 ppm (acid equivalent). In terms of mean acute values for the genera, values ranged from 23 to 151 ppm (figure B-1). Chronic toxicities of the endothall salts were usually only five times lower than the acute-toxicity data for the species. Chronic toxicities ranged from 5 ppm to 80 ppm, and acute chronic ratios averaged 5.2, with 95 percent confidence limits of 0.17-163 (table B-1).

ACUTE CHRONIC RATIOS FOR ENDOTHALL SALTS

TABLE A-2-1

Species	Acute	Chronic	Acute Chronic Ratio
Red Shiner	84	32	2.6
Redfin Shiner	76	32	2.4
Bluegill	127 1/	80	1.6
Rainbow Trout	151 1/	6.3 2/	24
Largemouth Bass	131 1/		816.4

Geometric Mean Acute Chronic Ratio = 5.2
95 Percent Confidence Limits = 0.17 - 163

1/A species mean acute value was used.
2/A species mean chronic value was used.

Data available for the endothall amine (Hydrothol 191) only concerns acute toxicities, which ranged from 0.18 to 1.3 ppm. Endothall amine is, in terms of median acute toxicity, 100 times more toxic than endothall salt. Because there were no chronic toxicity data for endothall amine, the final chronic value was estimated by dividing the mean acute values for the genera (figure B-2) by the average acute chronic ratio of 5.2 for endothall salts. Dividing the generic mean acute values for endothall amine, which ranged from 0.36 to 1.06 ppm, by the acute-chronic rate of 5.2 yields final chronic value estimates ranging between 0.07 and 0.20 ppm.

FIGURE A-1

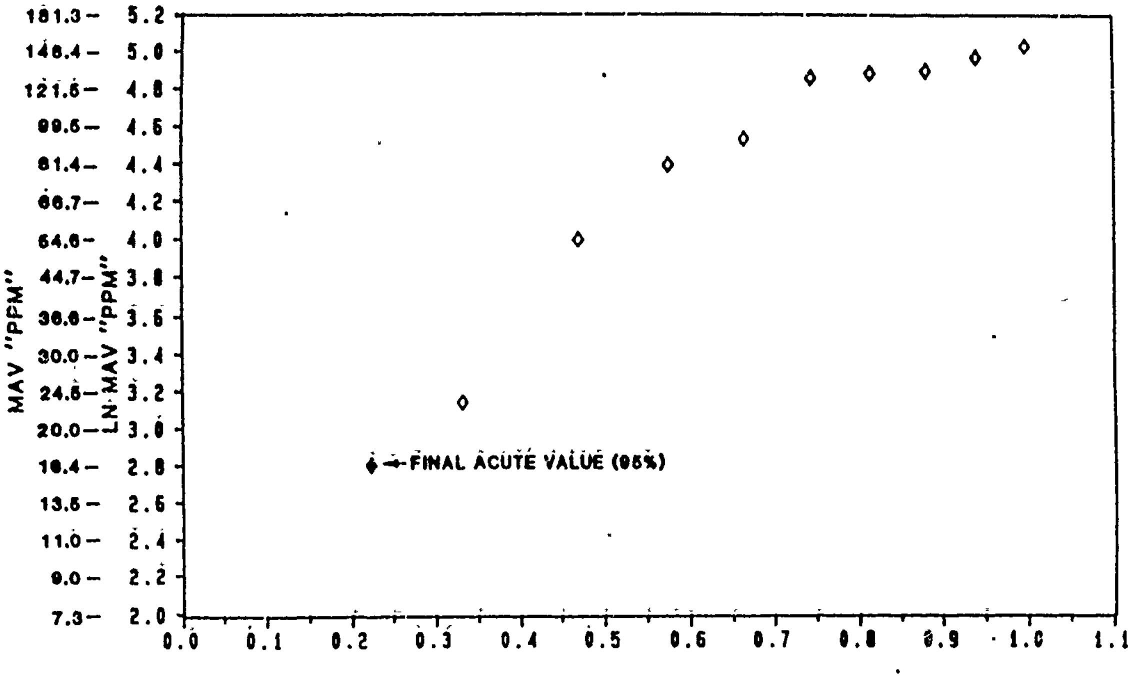

Figure A1. Distribution of the mean acute values (MAV) for the genera tested with endothall salts in relation to the estimated final acute value (FAV), above which lie 95% of the acute toxicity data considered. The LC50s/EC50s are transformed to the natural logarithm and cumulative probabilities to the square root, as per Erickson and Stephan (1985).

FIGURE A-2

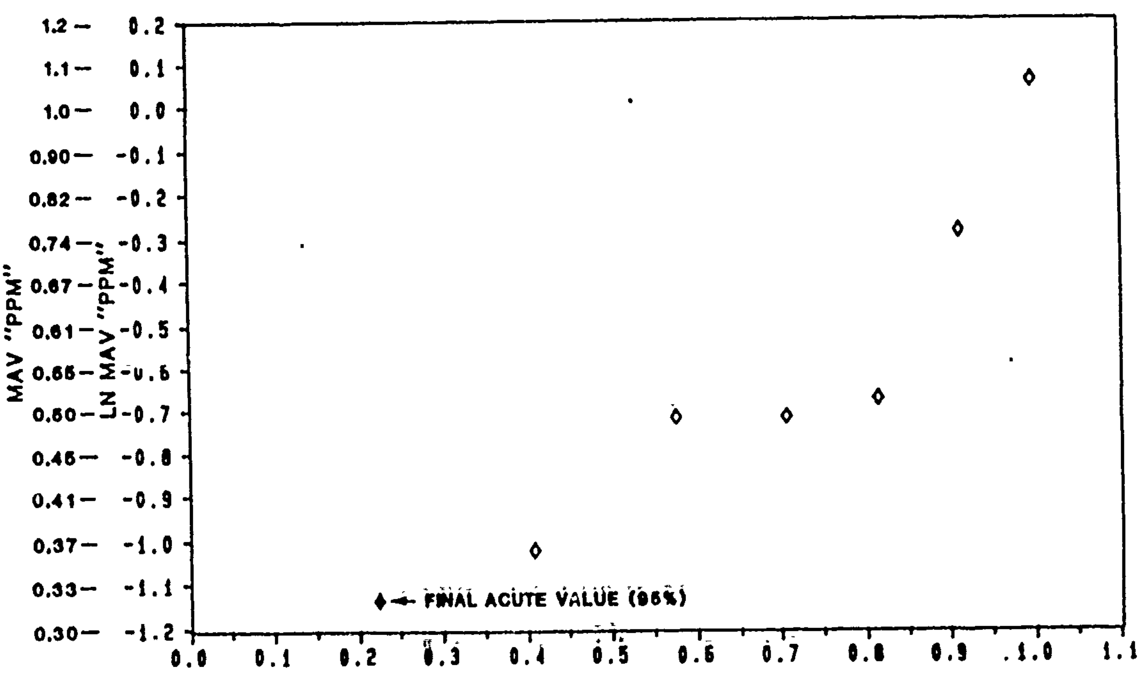

Figure A2. Distribution of the mean acute values (MAV) for the genera tested with endothall amine in relation to the estimated final acute value (FAV), above which lie 95% of the acute toxicity data considered. The LC50s/EC50s are transformed to the natural logarithm and cumulative probabilities to the square root, as per Erickson and Stephan (1985).

Fluridone's (Sonar) acute toxicity to aquatic life lies in the range of 1.3 to greater than 32 ppm. When the acute toxicity values were averaged according to the taxonomic grouping of the organism (to genera), the mean acute values ranged roughly along a straight line from 1.3 to 22 ppm (figure B-3).

Fluridone's chronic toxicity ranged from 0.2 to 1.2 ppm. Most of the chronic toxicity tests encompassed reproductive stages and were tied to acute toxicity tests, which permitted estimates of the acute-chronic ratios. Although the geometric mean acute-chronic ratio was 6.9, individual ratios were so variable that the 95 percent confidence limits for fluridone's acute chronic ratio ranged from 0.2 to 307. Because of this variability, there is a greater chance that aquatic life are being either under or overprotected from chronic toxicity (table A-2-1).

ACUTE-CHRONIC RATIOS FOR FLURIDONE

TABLE A-2-2

Species	Acute Value ppm	Chronic Value ppm	Acute Chronic Ratio
Fathead Minnow	22	0.96	22.9
<u>Daphnia magna</u>	4.3	0.2	21.5
Channel Catfish	11.7	1.0	11.7
<u>Gammarus pseudolimnaeus</u>	2.9	1.2	2.4
Midge	1.3	1.2	1.1

Geometric Mean Acute-Chronic Ratio = 6.9
95 Percent Confidence Limits = 0.20 - 307

FIGURE A-3

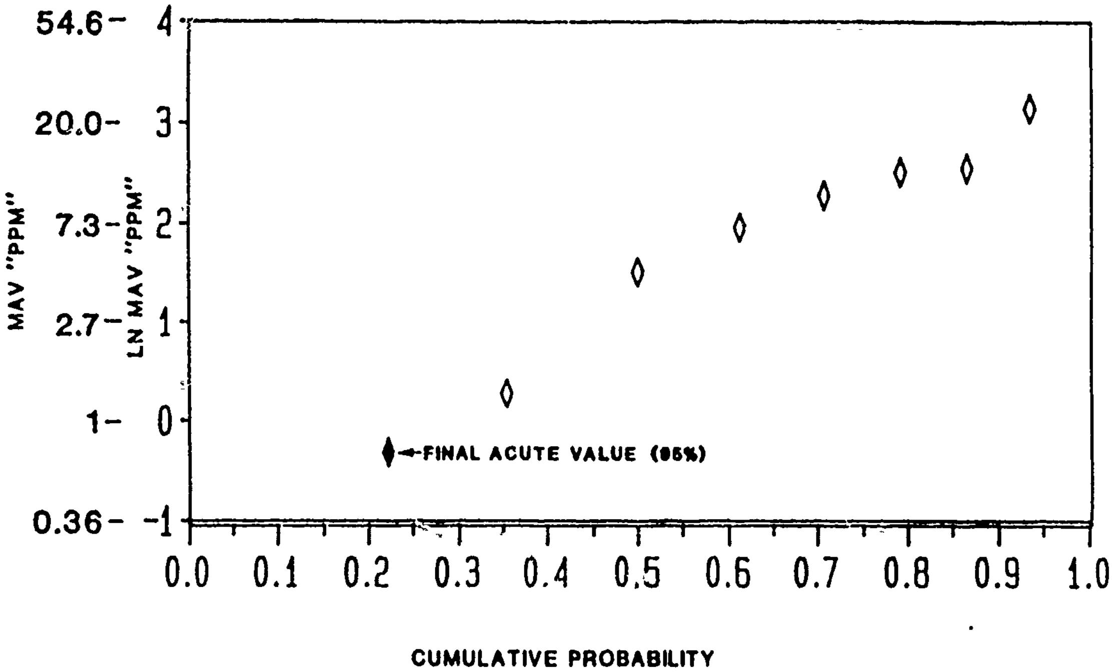

Figure Distribution of the mean acute values (MAV) for the genera tested with fluridone in relation to the estimated final acute values (FAV), above which lie 95% of the acute toxicity data. The LC50s/EC50s are transformed to the natural logarithm and cumulative probabilities to the square root, as per Erickson and Stephan (1985).

APPENDIX A-3

LIMITS CONCERNING EPA'S OCS WATER QUALITY CRITERIA RISK ASSESSMENT

APPENDIX A-3

LIMITS CONCERNING EPA'S OCS WATER QUALITY CRITERIA RISK ASSESSMENT

The rationale concerning what percentage of the species to protect is discussed by Stephan (1985), who indicates that EPA believed that protecting 99 percent of the species produced a criterion that was too stringent, and that protecting 90 percent of the species produced a criterion that was too lenient. The compromise chosen was to protect 95 percent of the species. Statistically, there is substantially more uncertainty in a criterion protecting 99 percent of the species than in one protecting 95 percent. It is very difficult to detect significant impacts to 25 percent or even 10 percent of the species; thus, detecting impacts to a lesser proportion of the species is even more difficult. The program of Erickson and Stephan (1985) was modified to determine the critera protecting, theoretically, 90 percent, 80 percent, and 70 percent of the species in balanced populations. This modification was made in order to determine whether exceedance of a criterion protecting 95 percent of the species would have the potential for impacting a much larger percentage of the species in a population. It may also be of interest to determine whether decisions regarding the use of herbicides would change if it was considered acceptable to reduce the percentage of aquatic organisms to be protected. The concentration protecting 99 percent of the organisms was not estimated because (1) this appeared to constitute an unprecedented level of protection with respect to the EPA water quality criteria, and (2) would be highly uncertain in the statistical sense because of the relatively small sizes of the toxicity data bases.

Stephan et al. (1985) provide several options for evaluating the available data depending upon its characteristics. For example, they state: "depending on the data that are available concerning chronic toxicity to aquatic animals, the Final Chronic Value might be calculated in the same manner as the Final Acute Value or by dividing the Final Acute Value by the Final Acute-Chronic Ratio. In some cases it may not be possible to calculate a Final Acute-Chronic Value." This allowance provides some flexibility for developing a criterion in response to the available data's character.

When the available data were evaluated for acceptability for this assessment according to criteria in the Guidelines and ASTM (1985a), many studies could not be used for estimating water quality criteria. Some of the reasons for rejecting toxicity data, as well as exceptions made to data requirements, were as follows:

- A number of the studies were conducted with species not indigenous to the United States.

- Acute tests that were not of 96-hour duration were not used, except for (1) daphnids and other cladocerans (for which 48-hour tests were used), or (2) tests with embryos or larvae (for which tests ranging from 48- to 96-hour are appropriate).

- For acute tests with older life stages, the

96-hour EC_{50} was used if available. If the EC_{50} was unavailable, then the 96-hour LC_{50} was used.

APPENDIX B

HUMAN HEALTH RISK ASSESSMENT

APPENDIX B

HUMAN HEALTH RISK ASSESSMENT

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Comparison of Water Supply Ingestion MAC Value with
Ambient Endothall Concentrations: Aquathol
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Figure 2 B-21
Comparison of Water Supply Ingestion MAC Value with
Ambient Endothall Concentrations: Hydrothol Formulations

INTRODUCTION

Potential risks to human health as a result of herbicide application in Washington lakes were evaluated by METRO (1986). The population that could be exposed to lake water includes individuals of both sexes and sensitive subgroups such as infants, the ill or the elderly. Risks to applicators were not included in the assessment. This report is a summary of the procedures and results of the METRO risk assessment. In addition, new toxicity information released by EPA since 1986 substantially affects the risk assessment for endothall. A revised assessment using the same procedures used in the METRO study and the new toxicity criterion is included in Appendix B-4.

Three potential routes of human exposure were evaluated in the METRO study. These included:

- water ingestion
- dermal contact during swimming
- ingestion of aquatic organisms.

Two other routes of exposure were considered, but not included in the assessment since the potential for adverse effects by those routes was judged to be minimal. Inhalation of volatilized herbicide is unlikely to occur with endothall since its volatility is very low (Reinert and Rodgers 1984; Sikka and Rice 1973). During degradation of fluridone some volatile compounds are formed (Saunders and Mosier 1983), but according to METRO (1986) are unlikely to cause adverse effects due to the low toxicity of fluridone (Appendix A). The breakdown products themselves have apparently not been tested, however. Ingestion of crops irrigated with herbicide containing water was also not included in the assessment for the following reasons:

1) Product labels contain use restrictions and warnings about effects on non-target plants.
2) Damage to plants by herbicides in irrigation water would decrease the likelihood of human ingestion.
3) Intermittent use of the herbicides, and their dissipation and degradation, would preclude continuous use of irrigation water containing herbicides at significant concentrations.

To evaluate the potential for adverse effects, the estimated environmental concentrations (EECs) calculated from the herbicide application rates and persistence data were compared to criteria concentrations for human health. For each herbicide, an acceptable dose (AD) was determined after review of toxicity information (Appendix B-1). For both herbicides, the ADs used for all three exposure routes were derived from chronic oral studies in animals.

To relate an acceptable dose (AD) to a water concentration, models were developed which simulate the transport of the substance from the source to the receptor population for each of the exposure pathways of interest. Each pathway is expressed as an algebraic equation which is solved to calculate the Maximum Allowable Concentration (MAC) in water which results in an acceptable dose.

The basis for all the models involves quantifying the intake rate to determine an MAC in water for each route of exposure:

$$\text{Maximum Acceptable Concentration (MAC)} = \frac{\text{Acceptable Dose (AD)}}{\text{Intake Rate (IR)}}$$

The equations used for each of the potential exposure routes are described below.

WATER INGESTION

Procedure

A maximum acceptable water concentration for the water ingestion route was calculated by assuming that all of the acceptable dose is received in ingested water as follows:

$$MAC = \frac{AD}{IR}$$

where:

MAC = Maximum acceptable concentration (mg/l or ppm)
AD = Acceptable dose (mg/day) for 70 kg adult or 10 kg child
IR = Water ingestion rate (l/day)

Two different ingestion rates were used. The first was selected to represent the total amount of water that would be ingested on a daily basis (i.e., as if treated waters were the primary drinking water supply source). The second ingestion rate was selected to represent a more realistic water intake that could occur as incidental ingestion during swimming.

For the water supply intake rates, the standard intake values used by EPA for water quality criteria development were selected. For an adult, daily intake is equal to 2.0 l/day; for a child, intake is equal to 1.0 l/day. Incidental ingestion values were assumed to be equal to one tenth of the daily ingestion. Incidental intake is therefore equal to 0.2 and 0.1 l/day for adults and children, respectively.

Assessment

As noted above, new toxicity information on endothall released by EPA since the METRO report substantially affects the risk assessment. A revised risk assessment is presented in Appendix B-4. The risk assessment from the METRO report is summarized below.

Based on the assessment by METRO (1986), the maximum acceptable concentrations determined for ingestion exposure are compared to the initial ambient herbicide concentrations in Table 1. Initial concentrations of the endothall amine formulation (Hydrothol) exceed the water supply MAC values for adults and children. For the salt formulation of endothall (Aquathol), initial concentrations exceed the chronic water supply MAC value for a child. As shown in Figures 1 and 2, the resultant ambient concentrations for the

endothall formulations would decline below the critical chronic level of 1.5 mg/l for a child in less than 15 days for Aquathol and in less than 20 days for Hydrothol if the half-life is the longest shown (eight days). No exceedances of the fluridone MAC are predicted. Similarly, no exceedances of the short-term incidental ingestion MAC values are observed for any of the herbicides.

For both fluridone and endothall, the short-term exposure was evaluated using the same AD as for chronic exposure (Appendix B-1). The results of the above analyses indicate that applications of endothall or fluridone should not pose a long-term threat to human health. Very conservative analyses of ingestion of herbicide treated waters indicate that under typical conditions waters used for drinking water would cause no observable increased risk after at most 20 days for endothall. Initial concentrations of fluridone would not interfere with water usage. For incidental ingestion during recreation, none of these herbicides would lead to increased risk to human health.

DERMAL EXPOSURE

Procedure

The potential for harm resulting from dermal exposure was evaluated using a procedure which is recommended by EPA (1986b). The approach is based on the assumptions that contaminants are carried through the skin as a solute in water (rather than being preferentially absorbed independently of the water) and that the contaminant concentration in the water being absorbed is equal to the ambient concentration. Thus, the flux rate of water across the skin boundary is assumed to be the factor controlling the contaminant absorption rate. According to Scheuplein and Blank (1971) (as reported in EPA 1979), the flux rate of water through human skin ranges from 0.2 to 0.5 mg/cm^2/hr.

$$MAC = \frac{AD}{D \times SA \times Flux} \times \frac{1{,}000\ mg}{cc} \times \frac{1{,}000\ cc}{1}$$

where

MAC = Maximum Acceptable Concentration (mg/l or ppm) of contaminant in water
D = duration of an exposure event (hours), for swimming 1 hour per day is assumed
SA = skin surface area available for contact (cm^2)
SA = 18,150 cm^2 for an average adult 20-30 years old (EPA 1986b)
SA = 9,400 cm^2 for an average child 3-12 years old (EPA 1986b)
Flux = flux rate of water across skin (0.5 mass/cm^2/hr)
AD = Acceptable dose (mg/day) determined from ingestion studies, for 70 kg adult or 10 kg child

The AD as determined from ingestion studies is based upon the assumption that all of the ingested material is absorbed and is toxicologically available in the bloodstream. For dermal exposure, this AD is used to estimate the ambient concentration that will result in this same dose to the bloodstream from flux across the skin.

Assessment

As shown in Table 2, the initial ambient concentrations of endothall and fluridone do not result in exceedances of the MAC values computed on the basis of the ingestion AD. Recall that this procedure is based upon a toxicologically available dose of herbicide (i.e., absorption to the bloodstream). On this basis, a toxic response that would harm or impair human health is not indicated.

However, the MAC values presented in Table 2 do not account for the potential for skin irritation. Available information (Pennwalt 1986a) indicates that endothall is considered an irritant to both skin and eyes. Data reporting concentrations associated with irritation were not available. Therefore swimming in treated waters is not recommended until ambient concentrations decline to low levels. Endothall product labeling indicates that waters may be used for swimming 24 hours after application.

Studies conducted by Ansley and Levitt 1981, Arthur et al. 1978a, and Probst et al. 1982, indicate that fluridone is not irritating to skin. Application of undiluted fluridone formulations to the eyes of rabbits resulted in slight conjunctivitis (inflammation of the eyelid membrane) and corneal dullness. All treated eyes were normal within two to seven days (Ansley and Arthur 1980, Ansley and Levitt 1981, Arthur et al., 1978a and 1978b). Ambient exposure concentration while swimming will be very dilute compared to direct product exposure. Therefore, serious or long-term irritation as a result of dermal or ocular fluridone exposure is not expected to occur and swimming in treated waters is not expected to cause an observable increased risk of irritation.

INGESTION OF AQUATIC ORGANISMS

Procedure

The MAC value calculated for ingestion of aquatic organisms is equivalent to the concentration commonly called the Final Residue Value in the guidelines for developing EPA water quality criteria (Stephen et al. 1985). The MAC is calculated from the fish ingestion rate and bioconcentration factor as shown below:

$$MAC = \frac{AD}{FI \times BCF}$$

where:

MAC = Maximum Acceptable Concentration of contaminant in water
AD = Acceptable dose (mg/day) for 70 kg adult
FI = Fish Ingestion Rate (kg/day)
= 6.5 g/day for adults = 0.0065 kg/day (EPA, 1980b)
BCF = Bioconcentration Factor (l/kg) (highest reported values used)

Assessment

Bioconcentration data available for both herbicides (refer to Appendix B-3) indicated that bioconcentration factors were far too low (zero for endothall, 0.94 to 2.46 for fluridone) to be of concern in terms of bioaccumulation and biomagnification. The bioconcentration factor is a measure of the extent to which a chemical accumulates in the aquatic animal solely as a function of exposure to the chemical in the water. Bioaccumulation reflects uptake from the water plus from the food. Biomagnification represents the increased concentration of a chemical as predators eat prey in a food chain. ASTM (1985b) indicates that chemicals with bioconcentration factors less than approximately 100 have low potential for causing harm to wildlife and human health via biomagnification of residues up food chains. Kimerle et al. (1978) suggest that studies of impacts arising from biomagnification need only be performed when bioconcentration factors in muscle tissue exceed 1,000. Fluridone's bioconcentration factor averaged 1.5; 95 percent confidence limits ranged from 0.5 to 5.3. No bioconcentration of the endothall salts in excess of the concentration in the water has been reported. Pennwalt Corporation staff indicated that endothall does not contaminate fish tissue based on their tests. Based on its low affinity for fats, bioconcentration factors around 1 are expected (Reinert et al. 1986).

As expected, calculation of the fluridone MAC or Final Residue Values for ingestion of aquatic organisms confirmed that this exposure route does not endanger human health. The residue values are compared to ambient exposure concentrations in Table 3.

SUMMARY AND CONCLUSIONS

A 1986 METRO study of risks to human health from application of the herbicides endothall and fluridone to Washington lakes has been summarized. A revised risk assessment for endothall utilizing toxicity information recently released by EPA was also performed. Three potential routes of human exposure were evaluated. These included:

- water ingestion
- dermal contact during swimming
- ingestion of aquatic organisms.

To evaluate the potential for adverse effects, the estimated environmental concentrations calculated from the herbicide application rates and persistence data were compared to criteria concentrations for human health. For each route of exposure, an acceptable dose (AD) was determined after review of toxicity information and EPA's risk assessment data base (integrated risk information system or IRIS). EPA's chronic risk reference dose (RfD) for ingestion exposures was used for both herbicides as the AD for all three exposure routes evaluated. A model was used for each route of exposure to derive a maximum acceptable concentration (MAC) of the herbicide in water by dividing the AD by an intake rate.

For water ingestion, two intake rate scenarios were used: a worst-case analysis assuming the herbicide-treated water was used as the drinking water supply, and a more likely exposure scenario assuming incidental water

ingestion while swimming. The incidental ingestion scenario is still conservative because it was assumed that people were exposed daily for a prolonged time period (chronic exposure) to the initial herbicide concentrations. Potential exposures would actually be much more limited. Application of herbicides is expected to occur once per year at most, and degradation half-lives reported in field studies range from one to eight days for endothall and five to 20 days for fluridone.

For fluridone, the estimated initial water concentrations did not exceed either the water supply MAC or the incidental ingestion MAC for adults or children. For endothall, initial concentrations exceeded the revised water supply MAC for both adults and children, and also exceeded the revised incidental ingestion MAC for children. In the previous risk assessment for endothall (METRO 1986), the incidental ingestion MAC was not exceeded for either adults or children. In the revised assessment, endothall concentrations in the water would not decline to the level of the incidental ingestion MAC for children for up to eight to twelve days (for the endothall-salt and endothall-amine formulations, respectively).

For the dermal exposure route and ingestion of aquatic organisms, the estimated initial concentrations did not exceed the calculated MACs for either herbicide. For dermal exposure, the model used to calculate an MAC was based on the assumption that contaminants are carried through the skin as a solute in water. Thus, the flux rate of water across the skin boundary was assumed to be the factor controlling the contaminant absorption rate. For ingestion of aquatic organisms, contaminant intake rate was calculated from a daily fish ingestion rate (6.5 grams/day) multiplied by a bioconcentration factor for accumulation of the contaminant in fish tissue.

In addition to potential risks from systemic absorption of the herbicides, there is a potential for effects from direct contact of herbicides with skin and eyes. Fluridone is not irritating to the skin and only minor effects were noted after application of undiluted fluridone to the eyes of rabbits. Thus, no adverse effects are expected from contact with dilute solutions. Endothall is considered an irritant to both skin and eyes, although no information was available on concentrations causing irritation. Endothall product labelling indicates waters may be used for swimming 24 hours after application.

In summary, no adverse effects are anticipated due to exposure to fluridone under the expected conditions of use. Use of endothall has some potential to cause adverse effects in children swimming frequently in recently treated waters, or in adults and children using recently treated water as their primary water supply. In addition, exposure to endothall in recently treated water has some potential to cause ocular and dermal irritation.

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TABLE 1

COMPARISON OF INITIAL HERBICIDE CONCENTRATIONS WITH MAXIMUM ACCEPTABLE CONCENTRATIONS FOR WATER INGESTION EXPOSURE 1/

Chemical	Initial Concentration (ppm)	Water Supply Ingestion MAC (ppm) Adult	Child	Exceedances	Incidental Ingestion MAC (ppm) Adult	Child	Exceedances
Endothall-salt	4.0	5.25	1.5	Yes	52.5	15	No
Endothall-amine	5.7	5.25	1.5	Yes	52.5	15	No
Fluridone-liquid	0.14	2.8	0.8	No	28	8	No
Fluridone-pellets	0.07 2/	2.8	0.8	No	28	8	No

1/ MAC in water based on AD calculated by METRO (1986) for chronic (lifetime) exposure (Appendix B-1).

2/ Maximum concentration after application calculated using longest half-life.

TABLE 2

COMPARISON OF INITIAL HERBICIDE CONCENTRATIONS
WITH MAXIMUM ACCEPTABLE CONCENTRATIONS
FOR DERMAL EXPOSURE 1/

Chemical	Initial Concentration (ppm)	Dermal Exposure MAC Adult (ppm)	Child (ppm)	Exceedance
Endothall-salt	4	1,157	319	No
Endothall-amine	2.5	1,157	319	No
Fluridone-liquid	0.14	617	170	No
Fluridone-pellets	0.07 2/	617	170	No

1/ MAC in water based on AD calculated by METRO (1986) for chronic (lifetime) exposure (Appendix B-1).

2/ Maximum concentration after application calculated using longest half-life.

TABLE 3

COMPARISON OF INITIAL HERBICIDE CONCENTRATIONS
WITH MAXIMUM ACCEPTABLE CONCENTRATIONS
FOR FISH INGESTION EXPOSURE 1/

Chemical	Exposure Period	Initial Concen-tration (ppm)	BCF 2/	Fish Ingestion Exposure MAC (ppm)	Exceedance
Endothall-salt	chronic	4.0	0	NA 4/	No
Endothall-amine	chronic	5.7	3/	NA 4/	No
Fluridone-liquid	chronic	0.14	2.46	350	No
Fluridone-pellets	chronic	0.07	2.46	350	No

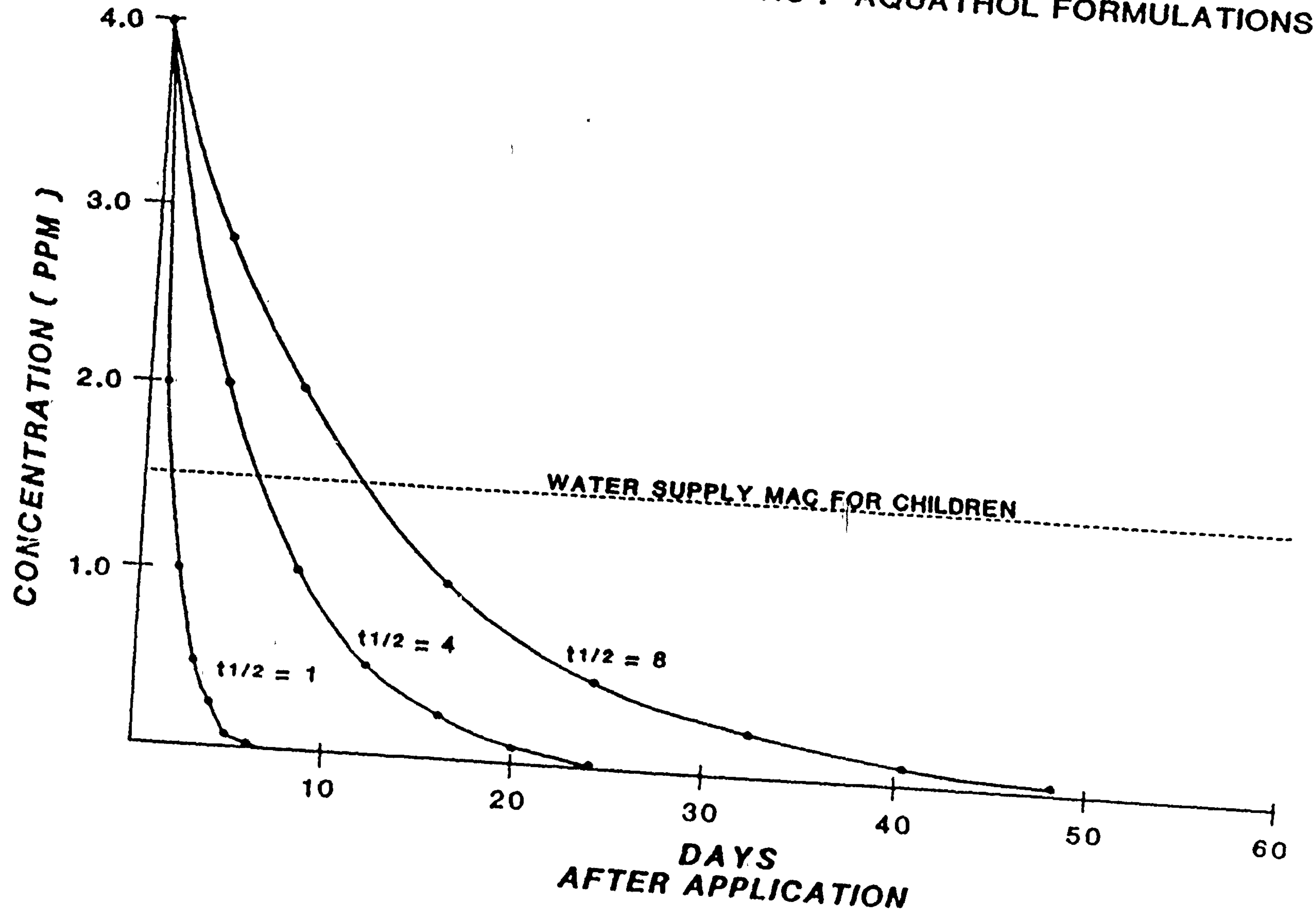
1/ MAC in water based AD calculated by METRO (1986) for chronic exposure.

2/ Bioconcentration factor = BCF.

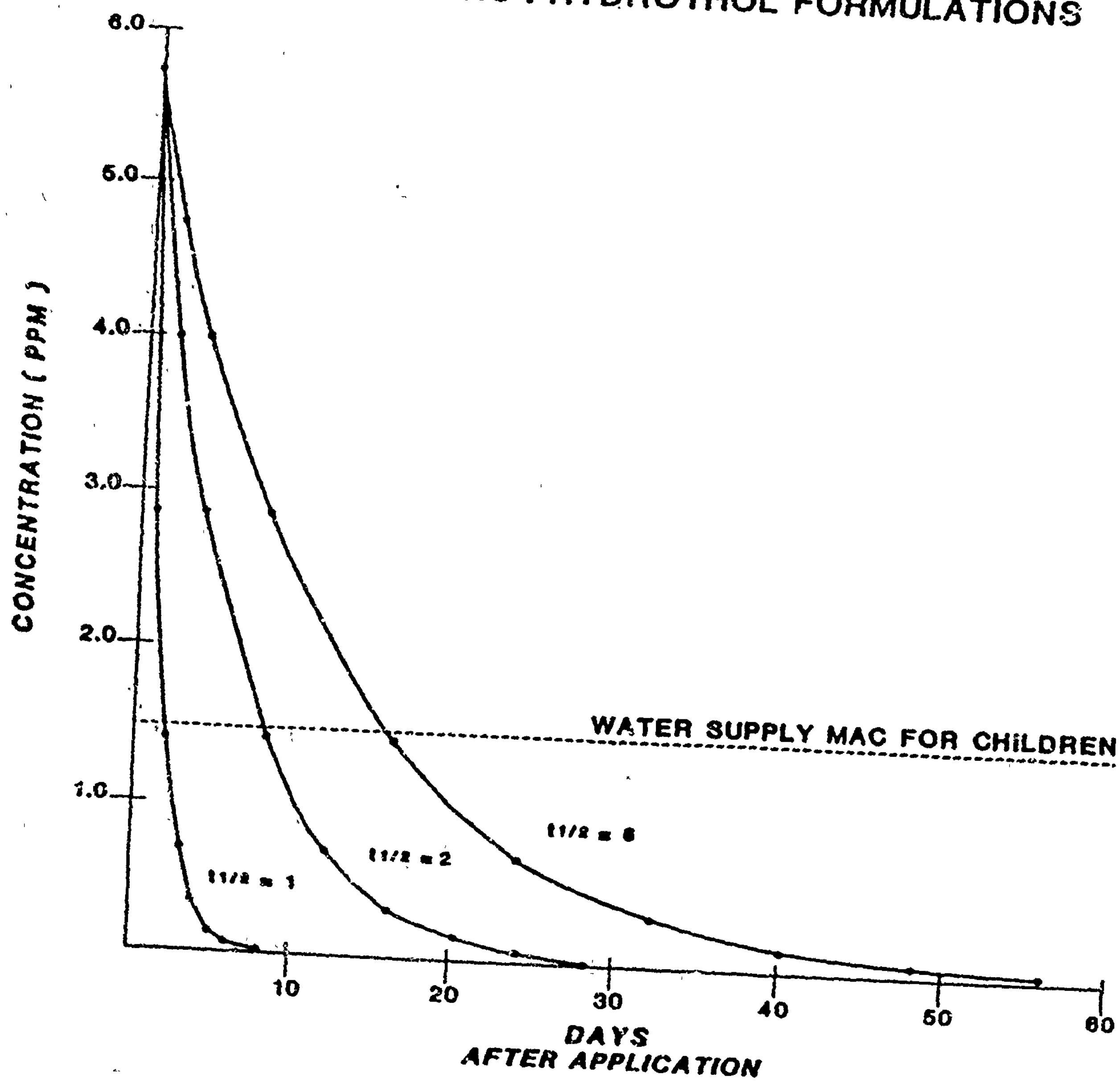
3/ BCF data not available. MAC cannot be computed.

4/ Does not contaminate fish tissue (Pennwalt Co., personal communication).

COMPARISON OF WATER SUPPLY INGESTION MAC VALUE WITH AMBIENT ENDOTHALL CONCENTRATIONS : AQUATHOL FORMULATIONS



COMPARISON OF WATER SUPPLY MAC VALUE WITH AMBIENT ENDOTHALL CONCENTRATIONS : HYDROTHOL FORMULATIONS



(PAGES B-15 through B-21 are intentionally left out of the Appendix. The gap was due to a numbering error.)

APPENDIX B-1
SUMMARY OF TOXICITY DATA

The potential human health effects of endothall and fluridone are described briefly below. Studies of endothall completed prior to 1980 were reviewed for Metro by Shearer and Halter (1980). Pennwalt Corporation provided results of recent and ongoing toxicity studies to METRO, which according to METRO (1986) support the findings of the earlier studies. For fluridone, which was not reviewed by Shearer and Halter (1980), the results of mammalian toxicity studies reviewed by METRO (1986) are summarized in Appendix B-2.. Much of this information was obtained via Freedom of Information Office requests. The objective of the toxicity evaluation performed during the METRO study was to calculate an acceptable dose and identify the resulting potential for adverse effects. Acceptable dose (AD) was defined as an average lifetime intake rate that is unlikely to cause adverse effects on human health. Emphasis was placed upon regulatory guidance available for fluridone. In the absence of regulatory criteria or guidelines for endothall, a methodology consistent with the EPA drinking water criteria development methodology was employed. The AD values determined by METRO (1986) for the two herbicides are summarized in Table B-1-1. The basis for METRO's AD determinations are detailed below.

Endothall

Acute effects of undiluted endothall are due to its corrosive properties rather than systemic effects. Endothall is poorly absorbed through the skin, lungs or gastrointestinal tract unless the membrane is first damaged. At low doses acute effects include local irritation to skin, lungs and eyes. High doses can be fatal.

Research summarized in Shearer and Halter (1980) and current data provided by Pennwalt Corporation (1986) indicate that endothall is not teratogenic or mutagenic to mammals. Shearer and Halter (1980) report that results of one test indicated a mutagenic effect in fruit flies. Oncogenicity testing done in the 1950s and in 1979 have indicated no increase in tumor production. An ongoing study due for completion in 1987 also showed no increased tumor production after one year. Thus available information indicates that endothall is not carcinogenic.

The Acceptable Dose (AD) for endothall used in the METRO study was determined by applying an appropriate safety factor to a No Observed Effect Level (NOEL) (Table B-1-2). Since the lowest NOEL reported was 15 mg/kg/day and this value was reported for multiple studies, the 15 mg/kg/day was selected at the basis for the human AD. According to EPA guidelines (U.S. EPA 1985b) an uncertainty factor of 100 is appropriate when extrapolating from valid results of long-term studies in animals. Therefore, the human AD used to evaluate potential health effects from exposure to endothall was 0.15 mg/kg/day. This value represents an appropriate AD for long-term exposure and was, therefore, viewed as extremely conservative for evaluation of potential risks resulting from occasional herbicide use. Data which would permit estimation of a short-term AD similar to the 24-hour health advisory levels for 2,4-D were not available.

Since the METRO study was done, EPA's RfD work group has completed an evaluation of endothall (EPA 1988). They derived a Risk Reference Dose (RfD) of 0.02 mg/kg/day, based on a NOEL of 2 mg/kg in a two-year feeding study in dogs. At the lowest observed effect level (6 mg/kg), increased absolute and relative weights of stomach and small intestine were noted. The confidence in this RfD was rated as medium, mainly because of the lack of adequate data from a chronic rat feeding study (repeat study in progress). No review of the carcinogenicity of endothall is underway at EPA and it is not known if an adequate study has been completed. A revised risk assessment for endothall based on the EPA RfD appears in Appendix B-4.

Fluridone

At extremely high doses, fluridone has been shown to affect growth and survival rates, organ weights and function, and blood chemistry. In general, fluridone exhibits low toxicity, as evidenced by the high concentrations required to induce an effect. Studies performed to date have found no evidence of carcinogenicity, teratogenicity, or mutagenicity for this herbicide.

Health risk assessment information for fluridone has been compiled in EPA's Integrated Risk Information System (IRIS)(EPA 1986a). The Risk Reference Dose (RfD) for oral exposure recommended by EPA is 0.08 mg/kg/day. This value is based upon an NOEL level for glomerulonephritis (kidney effects) of 8 mg/kg/day in studies in rats and an uncertainty factor of 100. The EPA RfD was used in this study as the AD with which to evaluate the potential for harm to human health. In 1988, EPA's RfD work group completed a reevaluation of the fluridone data (EPA 1988). The oral RfD remained the same and was given a high confidence rating. No data gaps were noted. An assessment of the carcinogenic potential of fluridone was just completed by EPA's cancer risk assessment work group (R. Engler, 1988). They concluded that fluridone is not carcinogenic, and classified the weight of evidence as "E;" i.e., no evidence for carcinogenicity in at least two adequate animal tests.

EPA (1986a) reports that the design of the critical study upon which the RfD is based exceeded minimal requirements and that the NOEL for both kidney and liver effects were supported by other Confidential Business Information (CBI) reviewed. The CBI information reviewed by EPA were also reviewed during this evaluation; a summary of available data is included as Appendix B-2.

Again, data were not available to estimate a short-term AD. The chronic AD value represents a very conservative approach for evaluating potential risks resulting from occasional fluridone application.

TABLE B-1-1

ACCEPTABLE DOSE (AD) VALUES FOR
ENDOTHALL AND FLURIDONE

	Exposure Period	AD (mg/kg/day)	AD for 70 kg Adult (mg/day)	AD for 10 kg Child (mg/day)
Endothall	Chronic	0.15	10.5	1.5
Fluridone	Chronic	0.08	5.6	0.8

TABLE B-1-2

SUMMARY OF ORAL ADMINISTRATION CHRONIC TOXICITY TESTING DATA FOR ENDOTHALL 1/

Species	Study Date	NOEL (ppm in diet)	NOEL 2/ (mg/kg/day)
Rat	pre-1957	300	15
Rat	1975	male, 1,200 female, 2,400	60 120
Rat 3/	1986	300	15
Dog	pre-1966	800	20
Rat 4/	pre-1966	300	15

1/ Data provided by Pennwalt Corporation (1986a).

2/ ppm in feed converted to mg/kg using 1 ppm = 0.05 mg/kg/day for an adult rat and 1 ppm = 0.025 mg/kg/day for a dog (USFDA 1959).

3/ Two year ongoing study; results from interim sacrifice at 1 year.

4/ Three generation reproduction testing.

APPENDIX B-2

SUMMARY OF MAMMALIAN TOXICITY DATA

APPENDIX B-2

SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Ringer et al. 1981	Bobwhite Quail *Colinus virginius*	M,F (50:500)	112371 EL 171	range = 0.00-0.1% in diet	24 weeks	Chronic (1 generation)	Oral	NOEL	No observed effect
	Mallard Duck *Anas platyrhynchos*	sex unknown (28) M,F (2:5)	112371 EL 121	0.1 % in diet	27 weeks	Chronic	Oral	NOEL	No observed effect
Meyerhoff and Brannon 1982	Rats			8.5 mg/kg/day	2 years	Chronic	Oral	NOEL	No observed effect
	Bobwhite Quail			2,000 mg/kg	14 days	Acute	Oral	No mortalities	
	Mallard, Bobwhite			5,000 ppm	8 days	Subacute	Oral (dietary)	No mortalities	
	Mallard, Bobwhite			1,000 ppm	24, 27 weeks	Chronic	Oral	NOEL	24 wks - Bobwhite 27 wks - Mallards
Pierson et al. 1981a	Rabbits (White New Zealand)	M,F (5:5)	112371	2 ml/kg Equivalent dose in mg/kg: 768(80% formulation), 384(40%), 192(20%	3 weeks (5 days/week)	Subchronic	Dermal	See Comments	Fluridone 4AS (80% in water): caused moderate-severe erythema, epidermal fissures, edema, slight desquamation. Fluridone 4AS (40%): caused well defined erythema, slight edema and desquamation. Fluridone 4AS (20%) caused transient erythema. Fluridone (80%, no water) caused a slight decrease in kidney weights for males. No other systemic toxicity was apparent
Pierson et al. 1981b	Guinea Pig (Albino Hartley Strain)	F (10) (Induction or Challenge) 5/group for Challenge Controls	Fluridone (Aqueous Suspension, AS)	See comments (Dose group A)	24 days		Dermal		Induction: dosed 3x/wk for 2 wks) Challenge: Dosing Commenced 10 days post final induction. (continued next page)

APPENDIX B-2(Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Pierson et al. 1981b (continued)									Group A: Dinitrochlorobenzene (DNCB): 0.2 ml of 0.1% DNCB in 70% ethanol for induction and challenge groups
	Guinea Pig (Albino Hartley Strain)	F (10) Induction or Challenge 5/group for Challenge Controls	Fluridone (Aqueous suspension, AS)	See Comments (Dose Group B)	72 hrs		Dermal	See Comments	Group B DNCB challenge control: 0.2 ml of 0.1% ethanol. No response evident (i.e., sensitization or irritation.
				See Comments (Dose Group C)	24 days		Dermal		Group C fluridone 4AS induction and challenge: 0.2 ml undiluted. No response evident.
				See Comments (Dose Group D)	72 hrs		Dermal		Group D fluridone 4AS challenge control; 0.2 ml undiluted. No response evident.
Adams 1980a	Rabbit (Dutch Belted)	F (5)	EL 171 112371	0 mg/kg/day 250 mg/kg/day 500 mg/kg/day 750 mg/kg/day 1000 mg/kg/day	Gestation days (6-18) Gestation days (6-18) Gestation days (6-18) Gestation days (6-18) Gestation days (6-18)		Oral (gavage)		No observed effect at 0, 250 mg/kg/day doses. Increased incidence of abortion at 500, 750, 1000 mg/kg (500: 1/4; 750: 1/5; 1000: 3/5). At the 3 highest doses there was a dose-related reduction of food consumption. Weight gain was depressed at 750 and 1000 mg/kg/day.

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APPENDIX B-2(Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Adams 1980b	Rabbit (Dutch Belted)	F (15)	112371	0 mg/kg/day 125 mg/kg/day 300 mg/kg/day 750 mg/kg/day	Gestation days (6-18) Gestation days (6-18) Gestation days (6-18) Gestation days (6-18)		Oral (gavage)	See Comments	No effect at 0, and 125 mg/kg/day doses. Abortions, death and increased absorptions at 300, 750 mg/kg/day though no evidence of teratogenic effects. Dose-related reduction of food consumption at 300 and 750 mg/kg/day.
Adams 1980c.	Rat (Fisher 344)	F (25)	112371	0 mg/kg/day 20 mg/kg/day 65 mg/kg/day 200 mg/kg/day	Gestation days 6-15	Subacute	Oral (gavage)	See comments	No effect on reproduction. No evident teratogenic effects. No maternal toxicity.
Adams 1980d	Rat (Fisher 344)	M,F (25:25)	112371	Average % in diet: 0%, 0.02%, 0.065%, 0.2%. Equivalent average doses in mg/kg/day: Male: 0, 11, 36, 112 Female: 0, 13, 42, 130	3 generations.	Chronic	Oral (Diet)	See comments	No apparent treatment related effects except a slight reduction in mean pregnancy weight at day 21 postpartum at the 0.2% dose.
Probst 1981a	Mouse (Strain ICR)	M,F (15:15)	EL-171	0.0033, 0.033, 0.01% in diet. Equivalent dose (mg/kg/day): Male: 3.2, 10.8, 30.9 Female: 3.6, 12.0, 34.1	1 year	Chronic	Oral (diet)	See comments	Increased in vitro activity of liver micromosal p-nitroanisole-o-demthylase. Relative liver weight increases for females at the 0.033% dose. Otherwise no effects on growth, survival, physical signs, hematology, clinical chemistry, or pathology.

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Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Probst 1981b	Beagle Dogs	M,F (4:4)	EL-171	75 mg/kg/day 150 mg/kg/day 400 mg/kg/day	1 year	Chronic	Oral (Capsule)	See comments	At 400 mg/kg/day: Dogs showed a slight decrease in body weight near end of study. Females: Elevated alkaline phosphatase from 5th week on and increased absolute liver weights. Otherwise no treatment effects related to hematology, urinalysis, liver enzyme induction, opthamology, or pathology.
Probst 1981c.	Mouse (ICR Strain)	M,F, (40:40)	EL 171	0.0033, 0.01, 0.033% in the diet. Equivalent dose in mg/kg/day: Males: 3.5, 10.9, 30.7. Females: 4.0, 12.3, 34.5	2 year	Chronic	Oral	See Comments	Males at 0.033% exhibited increased *in vitro* activity of liver microsomal *p*-nitroanisole O-demethylase. Otherwise, no tumors or effects on survival, growth, hematology, clinical chemistry, organ weights, or pathology
Probst 1980a	Rat (Fischer 344)	M,F (3:3)	EL-171	0.02, 0.065, 0.2% in diet. Equivalent dose (mg/kg/day): Male: 7.7, 25.2, 80.8 Female: 9.2, 30.1, 97.0	2 years	Chronic	Oral (diet)	See comments	At 0.2% (male and female): decreased survival, growth, and food consumption. Increased absolute weights for liver, kidneys. Increased incidence of renal tubular degeneration. Elevated blood urea nitrogen (BUN) and creatinine levels. (continued next page)

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APPENDIX B-2 (Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Probst 1980a (continued)									At 0.2% (females): Decreased erythrocyte count, hemoglobin and hematocrit. Dose related increase in the incidence and severity of progressive glomerulonephritis (kidney inflamation). Decrease in incidence of benign tumors.
Probst 1980b	Rat (Fisher 344)	M,F (15:15)	112371	Average % in the diet: 0, 0.02, 0.065, 0.20. Equivalent dose in mg/kg/day: 0, 9.4, 30.9, 95.9	1 year	Chronic	Oral	See comments	At 0.065 and 0.02% in diet (females): Initial growth retardation observed. Elevated in vitro microsomal p-nitroanisole O-demethylase activity. Elevated bilirubin levels. Initial growth enhancement also observed for some females at this dose. Decreased food consumption and decreased efficiency of food utilization. Decreased weight of adrenal; elevated liver, kidney, spleen and brain weights. At 0.2% in the diet (male and female): Decreased erythocyte count. Progressive glomerulonephritis. At 50.2% in the diet (male and female): Increased BUN levels. (continued next page)

APPENDIX B2(Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Probst 1980b (continued)									At 0.2% in the diet (males): Increased liver and kidney weights (absolute). Relative weights of liver, kidney, spleen and thyroid observed.
Hill 1981	Primary cultures from an adult male rat (Fischer 344)	-----	125670	500 moles/ml 1,000 moles/ml	20 hours	Acute	In vitro assay	Cyto-toxicity	No induction of DNA repair synthesis by 1-methyl-3-(4-hydroxy-phenyl)-5-[3-(tri-fluoromethyl)-phenyl]-4-[1H]-pyri-dinone (possibly a fluridone degradation product.)
Ansley & Levitt 1981	Rat (Fischer 344)	M,F (5:5)	112371, EL-171 Sonar 5p	500 mg/kg (Mixture)	Single dose with 7-day ob-servation.	Acute	Oral (gavage)		No mortality or signs of toxicity. Normal mean body weights.
	Rabbit (New Zealand White)	M,F (3:3)	112371 EL-171 Sonar 5p	2000 mg/kg (Mixture)	Single application with 7-day observation.	Acute	Dermal	See comments	No mortality or signs of toxicity. No dermal irritation.
	Rabbit (New Zealand White)	M,F (3:3)	112371 EL-171 Sonar 5p	2000 mg/kg (Mixture)	Single application with 7-day observation.	Acute	Ocular	See comments	Corneal dullness, slight iritis, at 1 hour post treatment in 2 animals (cleared within 24 hrs). Slight conjunctiv-itis in all eyes (cleared in 3-7 days). One male lost weight; all others gained weight.

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APPENDIX B-2 (Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Probst et al. 1978a	Mouse (ICR/SPF Strain)	M,F (15:15)	EL-171 112371	0.033, 0.056, 0.10, 0.14, 0.20% in diet. Equivalent dose (mg/kg/day): 49.5, 84, 150, 210, 300.	92-94 (days)	Subchronic	Oral (diet)	See comments	At top 3 dose levels (males and females): Increased liver weights. Females: Slight increase in leukocyte count and an increase in relative weight. Increase in hepatic microsomal activity (p-nitroanisole o-demethylase). At top 2 dose levels (males): Increased hepatic microsomal activity (see above). At all doses (male): Increase in relative weights. Dose-related increase in hepatic hypertrophy. Otherwise, no effect on survival or weight gain.
	Mouse (ICR/SPF Strain)	M,F (15:15)	EL-171 112371	0.0062, 0.011, 0.02, 0.033, 0.056% in diet. Equivalent dose (mg/kg/day): 9.3, 16.5, 30, 49.5, 84.	91-93 (days)	Subchronic	Oral (diet)	See comments	Doses above 9.3 mg/kg/day resulted in dose dependent hepatic hypertrophy. Otherwise, no effects on liver weights, survival or weight gain.
Probst et al. 1978b	Beagle dog	M,F (1:1)	EL-171	100, 200 mg/kg/day	2 weeks	Subacute	Oral	See comments	Females at both doses showed slight anexoria. At 200 mg/kg/day: Emesis, and slight reduction in body weight. No effects on survival.

APPENDIX B-2(Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Probst et al. 1978b (continued)	Beagle dog	M,F (1:1)	112371	100 mg/kg/day 200 mg/kg/day	2 weeks	Subacute	Oral (capsule)	See comments	Slight anorexia of females at both doses. Emesis and slight reduction in body weight in both sexes at 200 mg/kg/day.
Probst et al. 1978c	Beagle dog	M,F (4:4)	112371	50 mg/kg/day 100 mg/kg/day 200 mg/kg/day	91 days	Subchronic	Oral (capsules)	See comments	For male and female at 200 mg/kg/day: lowered erythrocyte count, hemoglobin and hematocrit; BUN and alkaline phosphatase slightly elevated. For females at 100 mg/kg/day, relative liver weights increased.
Ansley & Arthur 1980	Rat (Wister)	M,F (5:5)	Sonar 5p	500 mg/kg (pellet form)	2-week observation.	Acute	Oral (gavage)	See comments	No mortality or signs of toxicity.
	Rabbit (New Zealand Albino)	M,F (3:3)	Sonar 5p	3 g/kg	2-week observation .	Acute	Dermal	See Comments	No mortality; signs of toxicity or dermal irritation.
	Rabbit (New Zealand Albino)	M,F (3:3)	Sonar 5p	138 mg/kg	1-week observation.	Acute	Ocular	See comments	Slight conjunctival redness 1 hr. post-treatment (cleared within 24-72 hours).
Arthur et al. 1978a	Rabbits (Albino)	M,F (3:3)	112371 (wettable powder)	2 g/kg	Single application, with 14 days observation.	Acute	Dermal	See comments	No toxicity or dermal irritation.
Arthur et al. 1978b	Rats (Harlan Wister)	M,F (5:5)	112371 (wettable powder)	2.45 mg/l (air)	1 hour with 14 day observation.	Acute	Inhale	See comments	No signs of toxicity.

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APPENDIX B-2(Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Arthur et al. 1978c	Rats (Wister)	M,F (5:5)	112371 (Aqueous Suspension)	0.5 ml/kg	Single dose with 14-day observation.	Acute	Oral (gavage)	See comments	Ptosis and hyperactivity observed within 3 hours (disappeared within 24 hours).
Arthur et al. 1978d	Rabbits (New Zealand Albino)	M,F (3:3)	112371 (Aqueous Suspension)	0.1 ml	Single dose with 7 day observation.	Acute	Ocular	See comments	All animals developed slight conjunctival hyperemia within 1 hour. Three had slight chemosis. Symptoms disappeared within 24-48 hours.
Arthur et al. 1978e	Rabbits (Albino)	M,F (3:3)	112371 (Aqueous Suspension)	2 ml/kg	1 application with 14 day observation.	Acute	Dermal	See comments	Mild erytheme & edema at treatment sights (all animals). Symptoms disappeared by day 6.
Arthur et al. 1978f	Rats (Wister)	M,F (5:5)	112371 (Aqueous Suspension)	9.6ml/L air	1 hour exposure with 14 day observation.	Acute	Inhale	See comments	Slight chromorhinorrhea and chromodacryorrhea (symptoms disappeared within 1 hour).
Arthur et al. 1978g	Wistar-derived rats (fasted over night)	(F) (10)	112371	2,000 mg/kg 3,000 mg/kg 4,500 mg/kg 7,000 mg/kg 10,000 mg/kg	Single exposure with 14 days observation.	Acute	Oral (gavage)	See comments	Animals fasted pretreatment. At 1-6 hours post treatment: diursis, leg weakness, hyperactivity, loss of righting reflex, ptosis and dyspnea. Most rats recovered 24 hours post-treatment. No deaths. Weight gain was normal.
Arthur et al. 1978h	Rabbits (New Zealand Albino)	M,F (1:3)	112371	27 mg	Single application with 7 day observation.	Acute	Occular	See comments	Slight conjunctivitis within 1 hour. Recovery within 72 hours.

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APPENDIX B-2 (Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Kehr et al. 1978a	Bobwhite quail	M,F, (5:5)	112371	2,000 mg/kg	Single dose 14 days observation.	Acute	Oral (gavage)	See comments	8 month-old animals utilized (fasted). No treatment-related effects (i.e., mortality or abnormal behavior).
Kehr et al. 1978b	Bobwhite quail	Unknown	112371	0.125, 0.250, 0.500% in diet	5-day exposure with 3 days Observation	Acute	Oral (Diet)	See comments	Ten day-old chicks utilized: At 0.25 and 0.50% in the diet statistically significant depression in body weight gain during days 0-3.
Kehr et al. 1978c	Mallard ducks	Unknown	112371	0.125, 0.250, 0.500% in diet	5-day exposure with 3 days observation	Acute	Oral (Diet)	See comments	16 day-old chicks utilized: At 0.025 and 0.50% in the diet reduced food consumption for days 0-5. At 0.125% some dietary rejection. Reduction in weight gain for all treated animals.
Probst et al. 1979	Rat (Fischer 344)	M (10)	EL 171	2.0 g/kg	Single exposure	Acute	Oral (gavage)	See comments	Reproductive performance of male rats not affected. No mortalities or weight change. No effect on mean litter size, resorption, or implantation. Fetuses all appeared normal.
Probst & Neal 1980a	Rat hepatocyte primary cultures (Fisher 344)	---	112371	Range 0.5 - 1,000 nmoles/ml	20 hours	Acute	In vitro Assay	See comments	No induction of DNA repair synthesis, as measured by autoradiography of unscheduled DNA synthesis (uds). Cytoxicity observed.

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APPENDIX B-2 (Continued)
SUMMARY OF FLURIDONE MAMMALIAN TOXICITY DATA REVIEW

Author	Species	Sex and No. per Dose Group	Chemical	Dose	Exposure Time	Type of Test	Route of Administration	Type of Response	Comments
Neal 1981	Chinese Hamsters	F (3)	112371	Range 62.5 - 500 mg/kg	Single exposure	Acute	Intraperitoneal	See comments	Fluridone did not induce SCE *in vivo* in bone marrow of Chinese hamsters. Cytotoxicity was observed at doses of 250, 350 mg/kg.

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APPENDIX B-3

BIOCONCENTRATION FACTORS FOR AQUATIC LIFE EXPOSED TO FLURIDONE AND ENDOTHALL SALTS

Species	Bioconcentration[a] Factor
	FLURIDONE
Brown bullhead *Ictalurus nebulosus*	2.46
Rainbow Trout *Salmo gairdneri*	2.30
Chub Sucker *Erimyzon sucetta*	1.92
Black bullhead *Ictalurus melas*	1.76
Green Sunfish *Lepomis cyanellus*	1.61
Warmouth Sunfish *Chaenobryttus gulosus*	1.42
Largemouth bass *Micropterus salmoides*	1.23
Tilapia *Tilapia sp.*	0.96
Bluegill *Lepomis macrochirus*	0.94
	ENDOTHALL SALTS
Algae, Daphnia and Fish	0

[a]References: Fluridone, West et al. (1983); Endothall Salts, McGaughey (1986).

APPENDIX B-4
REVISED RISK ASSESSMENT FOR ENDOTHALL

In early 1988, EPA issued a risk reference dose (RfD) of 0.02 mg/kg/day for chronic exposure to endothall (see Appendix B-1). This is almost an order of magnitude lower than the acceptable dose (AD) used in the METRO study. Use of the new RfD as the AD for endothall significantly changes the assessment of risks for water ingestion, but does not alter the outcome of the assessments of dermal exposure and ingestion of aquatic organisms. The ADs for adults and children are shown in Table B-4-1.

Water Ingestion

The maximum acceptable concentrations (MACs) for adults and children are shown in Table D-2, and were calculated following the same procedures used in the METRO study. As can be seen, the initial concentrations of both endothall formulations now exceed the water supply MACs (worst-case scenario) for adults and children. The ambient endothall concentrations will decline over time as shown in Figures 1 and 2. With the revised RfD, ambient concentrations will not decline below the water supply MAC for children for more than 35 days if the half-life is the longest one shown (8 days). The incidental ingestion MAC for children is also exceeded. Ambient levels would not decline below the incidental ingestion MAC for approximately eight days for endothall-salt (Aquathol) and 12 days for endothall-amine (Hydrothol). This exceedance is of greatest concern since incidental ingestion is the more likely exposure scenario.

It should be emphasized that this is an extremely conservative assessment since it uses an RfD developed for chronic (long-term) exposures and applies it to subchronic (short-term) exposures. Although a subchronic RfD has not been developed, a no observed effects level (NOEL) of 10 mg/kg/day was reported in a six week dog feeding study (EPA 1988). This is five times higher than the NOEL for the chronic study. This study may not have been adequate for development of a subchronic RfD, but five- to ten-fold differences between subchronic and chronic NOELS are typical. Use of even a three-fold higher subchronic RfD would result in an MAC higher than the initial endothall concentrations. Thus, periodic application of endothall might not pose a significant risk of adverse effects.

Dermal Exposure

The dermal MACs for children and adults are shown in Table B-4-3. For both adults and children the initial concentration of either endothall formulation does not exceed the MAC, so no adverse effects are expected from swimming for one hour per day in water containing the initial concentrations.

Ingestion of Aquatic Organisms

Although the bioconcentration factor (BCF) for the endothall-salt has been reported to be zero (see Appendix B-3), a BCF of one was used to calculate a final residue value for both endothall formulations. In both cases, the initial concentration did not exceed the final residue value, so no adverse

effects are expected in adults consuming up to 6.5 grams per day of fish living in waters containing the initial concentrations of endothall.

TABLE B-4-1

ACCEPTABLE DOSE (AD) VALUES FOR ENDOTHALL

	Exposure Period	AD (mg/kg/day)	AD for 70 kg Adult (mg/day)	AD for 10 kg Child (mg/day)
Endothall	Chronic	0.02	1.4	0.2

TABLE B-4-2

COMPARISON OF INITIAL HERBICIDE CONCENTRATIONS WITH MAXIMUM ACCEPTABLE CONCENTRATIONS FOR WATER INGESTION EXPOSURE 1/

Chemical	Initial Concentration (ppm)	Water Supply Ingestion MAC (ppm)		Exceedances	Incidental Ingestion MAC (ppm)		Exceedances
		Adult	Child		Adult	Child	
Endothall-salt	4.0	0.7	0.2	Yes	7.0	2.0	Yes
Endothall-amine	5.7	0.7	0.2	Yes	7.0	2.0	Yes

1/ MAC in water based on chronic (lifetime) exposure.

TABLE B-4-3

COMPARISON OF INITIAL HERBICIDE CONCENTRATIONS
WITH MAXIMUM ACCEPTABLE CONCENTRATIONS
FOR DERMAL EXPOSURE 1/

Chemical	Initial Concentration (ppm)	Dermal MAC Adult (ppm)	Dermal MAC Child (ppm)	Exceedance
Endothall-salt	4	154.3	42.5	No
Endothall-amine	2.5	154.2	42.5	No

1/ MAC in water based on chronic (lifetime) exposure.

TABLE B-4-4

COMPARISON OF INITIAL HERBICIDE CONCENTRATIONS
WITH MAXIMUM ACCEPTABLE CONCENTRATIONS
FOR FISH INGESTION EXPOSURE 1/

Chemical	Exposure Period	Initial Concentration (ppm)	BCF 2/	Fish Ingestion Exposure MAC (ppm)	Exceedance
Endothall-salt	chronic	4.0	1 3/	215	No
Endothall-amine		5.7	1 3/	215	No

1/ MAC for water based on chronic exposure.

2/ Bioconcentration factor = BCF.

3/ Worst-case estimate of BCF.

APPENDIX B-5

WORST CASE CALCULATIONS FOR NMF

APPENDIX B-5

WORST CASE CALCULATIONS FOR NMF

1. Merkle and Zeller[1] calculated that the NOEL (no effects level) for NMF was 10 mg/kg. Their experiments were repeated in 1988 by a contractor to Dow-Elanco and results confirmed the conclusions:

Rabbit	10 mg/kg/day NOEL
Rat	10 mg/kg/day NOEL

Under worst case calculations based on theoretical conditions:

(0.15ppm fluridone)	(36%)	(18%)	=	0.01 ppm NMF
EPA approved tolerance limit for fluridone in water in laboratory conditions	conversion of fluridone to NMF	molecular weight ratio of NMF/ fluridone		

Worst case NMF concentrations = 0.01 ppm = 0.01 mg/l.

2. Under more realistic conditions, based on actual experiments and data evaluated where NMF was not detected in Florida ponds after use:

"Realistic" case NMF concentrations in water would equal
< 0.002 ppm = < 0.002 mg/l

3. Assumptions made for safety assessment follow:

a. Concentration of NMF in water:
   - worst case concentration of 0.01 ppm = 0.01 mg/l
   - realistic case concentration of < 0.002 ppm = < 0.002 mg/l.

b. NMF model (no effects level) for teratogenesis = 10 mg/kg.

c. Average human body weight = 60 kg.

d. Average human body surface area at 60 kg = 17,000 cm^2.

[1] Merkle, J. and H. Zeller, 1980. Arzeimittel-Forschung, 30:1557-1562.

e. Average daily drinking water = 2 l.

f. Penetration rate of water through skin = 0.4 $mg/cm^2/hr$.

4. Drinking water worst case.

$$\frac{(0.01 \text{ mg/l } H_2O)\ 2\text{ l}}{60 \text{ kg body weight}} = 0.00033 \text{ mg NMF/kg}$$

$$\frac{10}{0.00033} = 30{,}303 \text{ x safety factor}$$

5. Percutaneous absorption during 8 hours exposure:

$$(0.4\ mg/cm^2/hr)\ (17{,}000\ cm^2)\ (8 \text{ hours}) = 54.400 \text{ mg } H_2O$$

6. Worst case of 0.01 ppm = 0.01 mg/l:

$$\frac{(0.01 \text{ mg NMF/l})\ (0.0544 \text{ l } H_2O)}{60 \text{ kg}} = 0.000009 \text{ mg NMF/kg}$$

$$\frac{10}{0.000009} = 1{,}111{,}111 \text{ x safety factor}$$

7. In summary,

Safety Factors	Worst Case	Realistic Case
Drinking Water	30,303 x>	149,254 x
Percutaneous Absorption	1,111,111 x>	5,555,555 x

Exposure to Equal the No Effects Level	"Worst Case"	"Realistic Case"
Drinking H_2O (amount needed to drink to reach NOEL)	15,852 gal/day>	78,077 gal/day
Percutaneous Absorption	1,014 years>	5,070 years

8. In conclusion, the use of fluridone according to label instructions does not pose any effect to human health. These are very large margins of safety, and the amount of water needed to drink to get to the NOEL is very unrealistic.